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Land Use Simulation Model of the Subalpine Coniferous Forest Zone

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Forest Service
U.S. Department of Agriculture

Abstract

A dynamic model simulates the short- and long-term hydrologic impacts of combinations of timber harvesting and weather modification to develop management strategies for planning intervals which can vary from a few years to the rotation age of subalpine forests (120 years and longer). Management strategies may subdivide a given "planning unit," defined by environmental characteristics, into as many as eight distinct "response units," which may be managed independently. Different cutting practices may be imposed on the response units, and any number of cuttings can be made at specified years during the planning interval. All interactions between the various response units are accounted for in both time and space. Moreover, the model contains time trend functions which compute changes in evapotranspiration, soil water, forest cover density, reflectivity, interception, snow redistribution, and sediment yield as the forest stands respond to timber harvesting.

Keywords: Computer models, coniferous forest, forest management, land use planning, simulation analysis, subalpine hydrology, watershed management.

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Land Use Simulation Model of the Subalpine Coniferous Forest Zone

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Introduction

Conflicts between interest groups over land-use impacts on the environment in the subalpine zone cannot be resolved without objective multi-resource analyses. These analyses must account for both primary resource responses and their interactions. Dynamic simulation models are one way of providing the framework for comprehensive land-use planning in ecologically complex forests. The output from such models should help planners to better understand how various land-use practices influence productivity and environmental quality. Moreover, multi-resource simulation models should help to achieve the most desirable balance of uses and products from the subalpine coniferous forest zone.

Some progress has been made in the development of simulation models that predict the short-term effects of timber harvesting on snowmelt and water yield (Leaf and Brink 1972, 1973a, 1973b, Leaf 1975). This work has been expanded to determine the long-term interactions between the water and timber resources in old-growth subalpine forests subjected to partial cutting and regeneration practices. The effects of logging and road construction on erosion and sediment yields are also considered.

The objective has been to design a model that: (1) is formulated in terms of the diverse form, structure, and arrangement of natural forest stands; and (2) at least qualitatively accounts for the response of these stands to management, based on the best information available.

Theory

Comparison of Subalpine Water Balance Model and Land Use Model

Leaf and Brink (1973a,b) have previously described a water balance model for simulating runoff from subalpine watersheds. This model is now being used in representative areas throughout the Rocky Mountain region for simulating watershed management practices and their resultant effects on hydrologic system behavior.

The Land Use Model has greatly expanded capabilities in that it utilizes the output from the Subalpine Water Balance Model (Leaf and Brink 1973b) to simulate both immediate and long-term effects of forest and watershed management on the water resource. Considerable flexibility is provided for simulating alternative silvicultural systems.

All but two of the subroutines in the core of the Subalpine Water Balance Model are used by the Land Use Model without significant changes; they are not discussed here, therefore, but are listed in Appendix II. Complete descriptions of the unrevised routines are also given in Leaf and Brink (1973a,b). Two subroutines, EVTRAN and CANVAP, were extensively revised as discussed later in this report. A "time-trend package" has been developed which simulates the long-term changes in the primary hydrologic variables. These variables are expressed in terms of accepted silvicultural concepts as described in this report.

In developing the Land Use Model, it was necessary to restructure the Subalpine Water Balance Model to make it the core system of a more versatile planning tool. The analytical framework of the Water Balance Model is a watershed divided into subunits defined by homogeneous environmental characteristics (slope, aspect, elevation, and forest cover composition and density). Hydrologic responses are computed for each subunit, then weighted according to their respective areas and combined to produce an overview of hydrologic system behavior on a watershed basis.

In the Land Use Model, the emphasis is shifted from the watershed to a "planning unit" of any size, which has all of the inherent characteristics of the hydrologic subunits discussed above, but which also accommodates the objectives of management. The Land Use Model is designed to simulate the effects of combinations of timber harvesting and weather modification in order to develop management strategies for planning intervals. These planning intervals can vary from a few years to the rotation age of subalpine forests (120 years and longer).

Management strategies may subdivide a given planning unit into as many as eight distinct areas or "response units" of any size, which may be man-

aged independently at varying points in time during the planning interval. Provision is also made so that different cutting practices may be imposed on the response units, and finally, any number of cuttings may be made on a given response unit at specified years during the planning interval.

Hydrologic integrity is maintained as management strategies are formulated, since all interactions between the various response units are accounted for in both time and space. Moreover, the overall hydrologic effects resulting from each management decision on the planning unit are projected to the end of the planning interval as though that decision were the final one in the strategy. Thus, the singular effects of each decision can be evaluated.

Table 1 compares the capabilities of the Subalpine Water Balance Model described by Leaf and Brink (1973a,b) and the Land Use Model described in this report.

Table 1.—Comparison of Subalpine Water Balance Model with Land Use Model

Factor	WBMODEL	LUMOD
Desired output	Watershed	Planning Unit
Secondary output	Subunit	Region
Method of computation	Subunits combined to yield watershed response	Response units combined to yield response for planning unit
Time trends	None	Yes
Erosion and sediment yield	None	Yes
Multiple treatments	Limited	Full range

Detailed flow chart descriptions and pertinent theory follow.

Land Use Model Configuration (Program LUMOD)

Program LUMOD is the controlling routine for a series of five relatively independent steps in the Land Use Model. The Control Data Corporation's 6400 FΦRTRAN Extended[2] provides Overlay capabilities which are ideally suited to the operation of the model. If such capabilities are not available, however, the five steps could be performed in a series of computer runs with communication among them through the use of magnetic tape files.

Procedural Differences from Subalpine Water Balance Model (fig. 1)

Step 1 (and to some extent, step 3) corresponds to the Water Balance Model described by Leaf and Brink (1973b). Both models utilize the Water Balance routines as their core.

Since climatological observations are rarely available for the long periods of time simulated by the Land Use Model, step 2 extends the data base by a randomized selection of water years until the planning interval is completed.

Both models contain peripheral routines which handle input/output and supply the continuous and static conditions to the core. It is the peripheral routines which embody the different objectives of each model.

The Water Balance Model was designed to simulate the effects of management strategies on an entire watershed over relatively short periods of time. Thus, computer memory was used extensively

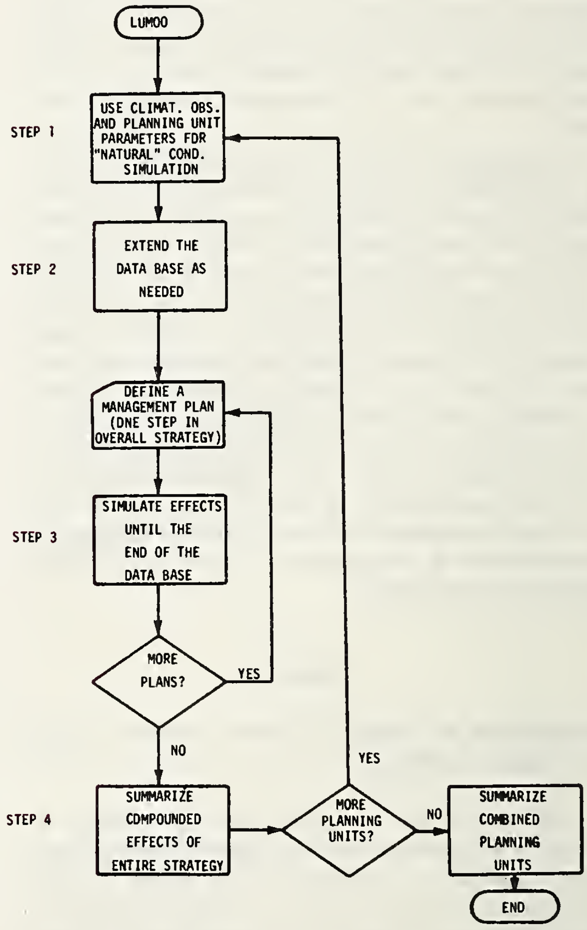


Figure 1.—General flow of Land Use Model.

for retaining simulated results until a composite overview was produced. Little use was made of online storage. In the Land Use Model, however, the objective has been to extend the capabilities of the Water Balance Model across a much longer time frame, with the added ability of introducing new management decisions at various points during the planning interval. Not only did we want the capacity to simulate each management decision independently, but we wanted to be able to view the interactive effects of a new decision on ones previously implemented. Moreover, an added objective was to simulate the effects of time, as demonstrated through reforestation, on each response unit at each point in the planning interval. It was therefore necessary to develop peripheral routines which were concerned with only one planning unit at one time. Use of computer memory was diminished as use of online storage increased to facilitate retention of: (1) input data for "multiple-passes"; and (2) voluminous output data which are summarized for the planning unit, watershed, and perhaps for a region comprising several watersheds.

Time Trends.—With the Water Balance routines collectively defined as the "core system" of the Land Use Model, it is useful to identify the time trends routines as "satellite" to the model, since they are accessed only once each water year as opposed to daily utilization of the "core system." Imposition of time trends on the simulation also required one additional means of communication (common block/TIME/) between routines.

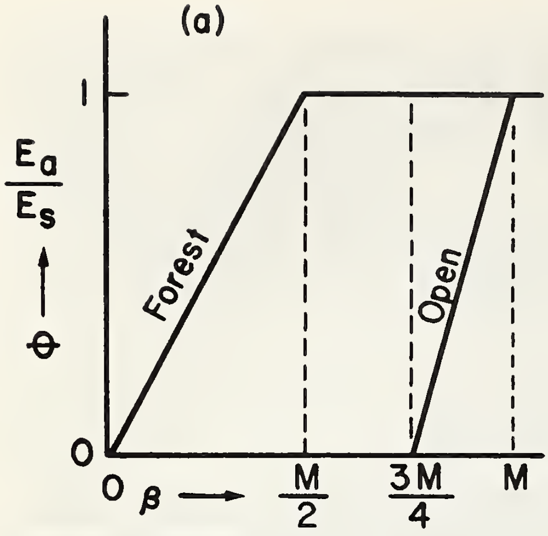
Response Units

A planning unit of any desired size is subdivided in the management strategy into as many as eight distinct management areas, called "response units", seven of which may be subjected to timber harvesting practices during a planning interval. It should be emphasized that a response unit need not be made up of a single forest area, but represents a percentage of the area of the entire planning unit. For example, consider a response unit that is 40 percent of the planning unit and subjected to patch-cutting. Such a unit is not considered as one very large forest opening, but rather as an array of small openings distributed over the entire planning unit and occupying 40 percent of its area. One response unit out of the eight is retained in the "natural" state to aid in simulating the redistribution of precipitation or weather modification. If the entire planning unit is managed, however, the area-weighting factor for the "natural" response unit is set to zero and it no longer affects the results. It is retained in the simulation, regardless of its weight, since the time trend functions cause the managed response unit to approach the same state as the natural response unit. All of the time functions are defined for each managed response unit, and are totally independent of the functions for other response units.

Model Subroutines

The routines discussed below are time trend routines that compute changes in evapotranspiration, soil water, forest cover density, reflectivity, interception, snow redistribution, and erosion and sediment yield. Peripheral routines, which are meaningful only in implementing the hydrologic and silvicultural concepts on a computer, are not discussed in detail here, but can be found in the FORTRAN listings in Appendix II. The remainder of the Water Balance routines that comprise the core system of the Land Use Model are also described in Leaf and Brink (1973b).

Evapotranspiration.—Subroutines EVTRAN and CANVAP, as described by Leaf and Brink (1973b), have been extensively revised to account for the regrowth of forest stands after harvest cutting. In computing evapotranspiration, there is some evidence that water use during the growing season proceeds at rates limited only by available energy until the soil water is depleted to 50 percent of the maximum "available" for transpiration (field capacity index). Thereafter, transpiration is decreased in proportion to the amount of soil water below one-half of the field capacity index. In open or cutover areas, it was reasoned that the absence of dense vegetation and a highly developed root system reduces evapotranspiration below maximum rates unless the soil mantle is completely recharged. Thereafter, evapotranspiration is linearly decreased to zero at three-fourths of the field capacity index (fig. 2a). As forest vegetation is established on cutover areas and consumptive use increases, the relationship in fig. 2a changes until ultimately, as the forest cover is reestablished, it approaches the old-growth forest curve (fig. 2b). It is this phenomenon which is primarily responsible for diminishing water yield increases from timber harvesting. The rate at which this transition takes place depends upon forest species, climate, stand conditions, and the objectives of management.



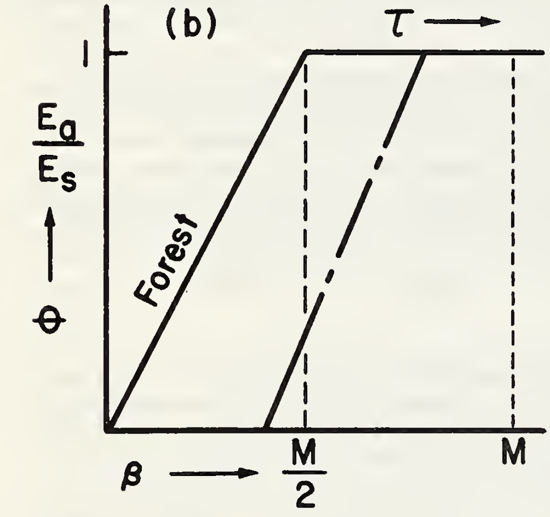


Figure 2.—Relationships showing evapotranspiration as a function of available soil water for: (a) old-growth forest and open conditions, and (b) old-growth forest and some intermediate forest cover condition several years after timber harvesting.

A general expression for the relations shown in figure 2 can be written as follows:

$$\Theta = \Delta \left[\beta - \left(\tau - \frac{1}{\Delta}\right)\right] = \Delta(\beta - \tau) + 1$$

$$\beta \geq \tau, \Theta = 1$$

$$\tau - \frac{1}{\Delta} < \beta < \tau \qquad [1]$$

$$\beta < \tau - \frac{1}{\Delta}, \Theta = 0$$

where θ = the ratio, $\frac{E_a}{E_s}$. E_a is the actual evapotranspiration rate and E_s is computed in this model by a modified version of the Hamon equation (Leaf and Brink 1973b).

β = the available soil water at any time. can vary between O and M, where M is the "field capacity index."

τ = the critical point at which available soil water begins to limit evapotranspiration. can vary between M/2 and M.

Δ = the slope of the relationship between E_a/E_s = 0 and 1.

In addition to complex factors such as ecological habitat and stand condition, the rate at which a forest reestablishes itself varies according to species. Discussions and background literature for the three major forest types of the subalpine zone are summarized by Alexander (1974). Of the three types, spruce-fir forests are the most difficult to regenerate, and therefore require the longest time for regrowth. Due to its seed production and growth habits, lodgepole pine does not require as much time to reestablish itself. Finally, since aspen normally regenerates from root suckers, a new stand promptly occupies the site, and on many sites growth exceeds that of associated conifers for decades.

Hydrologic changes resulting from timber harvest in the subalpine zone persist for many years. The Fool Creek watershed study in central Colorado (Hoover and Leaf 1967, Leaf 1975) resulted in water yield increases which did not show a significant decline more than 15 years after treatment. These results and results from timber management research were used to develop the time-trend relationships discussed below.

The procedure used in deriving the assumed time-trend equations was to: (1) establish plateaus, and maximum and minimum values for each hydrologic parameter; (2) establish critical values at which a transition takes place (that is, "when things begin to happen"); and (3) assume a functional relationship for each process which determines all intermediate values with respect to time.

Although the time-trend relationships may not be inherently correct, they are certainly plausible in light of our present understanding of long-term hydrologic phenomena. The validity of the equation should be determined by additional research.

Soil Water.—The critical point at which available soil water begins to limit evapotranspiration (τ) was assumed to vary with time and species (fig. 3):

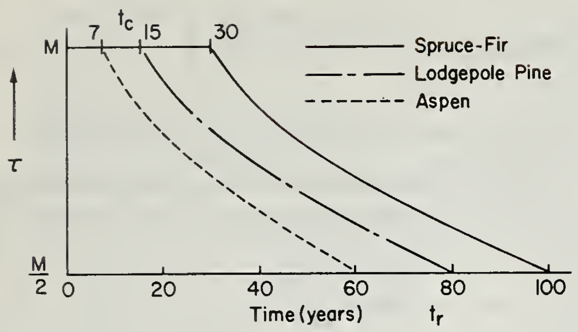


Figure 3.—Variation of τ with time and vegetation type.

$$\tau = Me^{-k(t - t_{c_1})} \qquad \begin{array}{l} \tau = M,\ t < t_{c_1} \\ \tau = M/2,\ t > t_r \end{array} \qquad [2]$$

where k = an index of the rate of decline of τ.
t_{c_1} = the time at which available soil water begins to limit evapotranspiration in years.
t_r = the time at which the hydrologic effect of timber harvesting becomes insignificant.

The parameters, k and t_{c_1}, vary according to forest species. When $t \leq t_{c_1}$, no adjustments are made in the soil water correction, since watershed experiments indicate that a correction is not warranted for a number of years after timber harvest. Assumed values of t_{c_1}, t_r, and k for the three species are:

Forest type	t_{c_1}	t_r	k
aspen	7 years	60 years	0.01
lodgepole pine	15 years	80 years	.01
spruce-fir	30 years	100 years	.01

The assumed relationship between Δ and τ is given by:

$$\Delta = \frac{4\tau}{M^2} \qquad [3]$$

Substituting equation [2] and [3] into equation [1] yields

$$\Theta = 4e^{-k(t - t_{c_1})} \left[\beta/M - e^{-k(t - t_{c_1})}\right] + 1 \qquad [4]$$

which is a general equation for θ as a function of forest cover type, field capacity index, and time.

Forest Cover Density.—Forest cover density plays an important role in the simulation model. It is the major descriptive parameter of the form, structure, and arrangement of forest stands, and therefore controls the energy balance, interception, and evapotranspiration. Forest cover density as used in the Land Use Model is not defined as "canopy" or "crown closure," but rather as a parameter that describes the net effects of the vegetation on the transmission of solar radiation to the forest floor. Forest cover density varies according to crown closure, the vertical foliage distribution, species, season, and stocking (Reifsnyder and Lull 1965). Empirical relationships between various timber stand variables and percent radiation beneath the forest canopy (transmissivity coefficient) have been determined from field measurements (Miller 1959, Muller 1971). A similar relationship was derived for the three major subalpine forest species in the process of calibrating the model against observed snowmelt rates (Leaf and Brink 1973a) and from solar radiation transmission studies in central Colorado. The resulting equation from this work is given by

$$T = 0.19\ C_{dmx}^{-0.6} \qquad [5]$$

where T = the transmissivity of the forest canopy expressed as a decimal fraction of the amount of solar radiation available above the forest canopy.
C_{dmx} = the natural old-growth forest cover density (expressed as a decimal).

Combinations of C_{dmx} and T that were found acceptable during calibration of the model for lodgepole pine, aspen, and spruce-fir in central Colorado are summarized below:

Forest type	C_{dmx}	T
lodgepole pine	0.25-0.45	0.40-0.30
spruce-fir	0.50-0.65	0.30-0.25
aspen		
foliated	0.35	0.35
defoliated	0.20	0.50

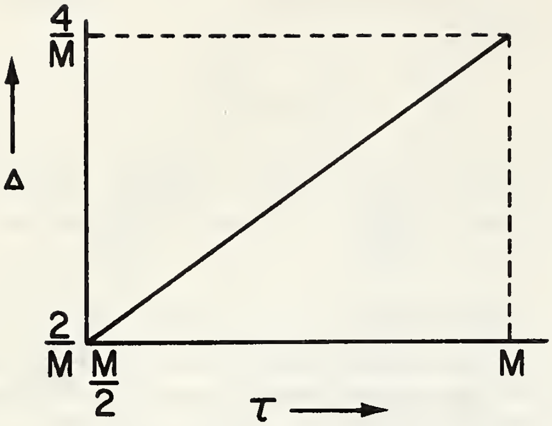


Figure 4.—Assumed variation of Δ as a function of τ.

As vegetation reoccupies cutover areas, forest cover density (C_d) increases with time until it reaches a maximum. Research has shown that the rate at which canopy development reaches this plateau depends on environmental conditions, stocking levels, and species. In coniferous forests, it can vary from 30 to more than 80 years; in aspen, growth and resultant canopy development is normally much more rapid due to the presence of an extensive root system at the time of stand regeneration (Pollard 1972). Accordingly, the following assumed relationship for C_d as a function of time was developed:

$$C_d = \frac{C_{dmx}}{\Phi^2}(t - t_{c_2})^2 \qquad t_{c_2} \leq t \leq \Phi \qquad [6]$$

where C_d = intermediate forest cover density expressed as a decimal.

Φ = the time in years from t_{c_2} at which maximum forest cover density is reached. This parameter was assumed to vary according to vegetation type as follows:

Forest type	Φ
lodgepole pine	40 years
spruce-fir	80 years
aspen	20 years and

t_{c_2} = critical time at which regeneration is sufficient to reestablish the stand when $t < t_{c_2}$, $C_d = 0$.

Reflectivity.—The relationship between reflectivity and forest cover density derived by Leaf and Brink (1973b) was modified as follows:

$$R_f = R_{fo}\exp\left[\frac{\omega C_{dmx}(t - t_{c_2})^2}{\Phi^2}\right] \qquad [7]$$

R_f = the reflectivity of the forest stand.

R_{fo} = the reflectivity of a forest opening (assumed herein as 0.5). When $t < t_{c_2}$, $R_f = 0.5$.

$\omega = 1.609\, C_{dmx}^{-1}$

Subroutine EVTRAN as used in the Land Use Model incorporates the effects of natural regeneration discussed above. As explained in the discussion for Subroutine TRENDS, the final computations of the adjustment factor for available soil water (equation 4) are performed in Subroutine EVTRAN, since they are dependent on the dynamic state of the soil mantle storage. The simulated potential evapotranspiration E_s is then adjusted for both available soil water and canopy reflectivity (equation 7) to produce the actual evapotranspiration E_a. It should be noted that equation 7 is constant over a water year and is recomputed after each growing season. Subroutine EVTRAN also alters the soil mantle storage according to the calculated evapotranspiration.

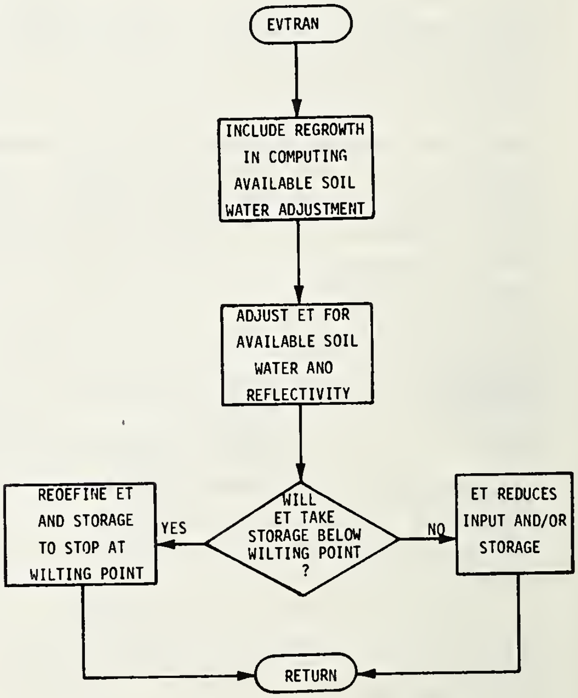


Figure 5.—Subroutine EVTRAN.

Interception.—Subroutine CANVAP (Leaf and Brink 1973b) is essentially unchanged except that allowance is made for snow interception as the forest regrows after harvest cutting, by weighting the effects of both snow evaporation from areas not occupied by trees (SNOWVAP in Leaf and Brink 1973b) and evaporation from intercepted snow. In the Land Use Model, evaporation from the snow surface and from intercepted snow is computed by the following rational relationships:

$$V_s = (1 - C_d)E_s \text{ and} \quad [8]$$

$$V_c = (1/C_d)E_s \quad [9]$$

where V_s = evaporation from the snow surface.

V_c = intercepted snow evaporation.

C_d = intermediate forest cover density expressed as a decimal, where $C_d < C_{dmx}$.

E_s = potential evapotranspiration as defined in equation [1].

When $C_d \geq \frac{C_{dmx}}{2}$, and snow rests on the canopy, evaporation is computed by equation [9]; when the canopy is free of snow, evaporation takes place according to equation [8]. However, when $0 < C_d < \frac{C_{dmx}}{2}$, both equations [8] and [9] are used as follows:

$$V_t = E_s \left[\frac{2}{C_{dmx}} + \left(1 - \frac{2C_d}{C_{dmx}}\right)\left(1 - C_d\right)\right] \quad [10]$$

V_t = combined evaporation from snow surface and intercepted snow in cutover areas.

We believe that equation [10] more realistically represents the evaporation from cutover areas that are not completely occupied by forest vegetation. When $C_d = 0$, $V_t = V_s$. By substituting equation [6] into equation [10], the following relationship is obtained:

$$V_t = E_s \left[\frac{2}{C_{dmx}} + \left(1 - \frac{2(t - t_c)^2}{\Phi^2}\right)\left(1 - \frac{C_{dmx}}{\Phi^2}\left\{t - t_c\right\}^2\right)\right] \quad [11]$$

which expresses V_t as a function of C_{dmx} and time.

Snow Redistribution.—Redistribution of snow as a result of patch-cutting is a significant factor influencing runoff. In lodgepole pine, this phenomenon is not diminished more than 30 years after timber harvest in spite of regrowth of trees and increased forest cover density (Hoover and Leaf 1967). Changes in natural snow accumulation patterns produced by patch-cutting will likely persist until the new crop of trees approaches the height of the surrounding forest. Accordingly, the following relationships were developed for simulating snow redistribution effects with time and forest species:

$$\rho = \rho_{mx} \exp\left[-k_1(t - t_{c_3})\right] \qquad \begin{matrix} t \leq t_{c_3}, \rho = \rho_{mx} \\ t \leq t_{r_1}, \rho = 1 \end{matrix} \quad [12]$$

where ρ = snow redistribution factor in the cutover area, which varies according to the silvicultural system used. For example, when 40 percent of the area is occupied by small openings 5 tree-heights in diameter, the winter snowpack is increased by 30 percent in the open and decreased 20 percent in the uncut forest.

ρ_{mx} = the redistribution factor immediately after timber harvesting.

k_1 = an index of the rate of decline of ρ.

t_{c_3} = the time at which forest regrowth begins to reduce snow redistribution in years.

t_{r_1} = the time at which forest regrowth causes snow redistribution to become insignificant.

The parameters k, t_{r_1}, and t_{c_3} vary according to forest species. When $t \leq t_{c_3}$, no adjustments are made in the redistribution, since field studies indicate that a correction is not warranted for several years after harvest cutting. Assumed values of t_{c_3}, t_{r_1}, and k_1 for the three subalpine types are summarized below:

Forest type	t_{c_3}	t_{r_1}	k_1
aspen	20 years	80 years	0.57
lodgepole pine	40 years	120 years	.04
spruce-fir	80 years	160 years	.04

It should be emphasized that redistribution is optimum only when timber is harvested in small patches (5-8 tree heights in diameter) that occupy less than 50 percent of a given planning unit. For other combinations of opening size and area, the

redistribution factor should be reduced in proportion to the size of openings above and below 5 to 8 tree heights.

Individual-tree Selection Cutting.—In the Land Use Model, selection cutting corresponds to a reduction of the forest cover density (C_d). The degree that C_d is reduced depends on the characteristics of the stand and the volume of timber removed. If C_d is reduced by 50 percent or less from C_{dmx}, it is assumed that forest canopy density does not increase subsequent to cutting. However, if C_d is reduced more than 50 percent from C_{dmx}, equation [6] is used to simulate redevelopment of the canopy with time. Solving equation [6] for time yields:

$$t_\eta = \left(\frac{\Phi^2 C_d}{C_{dmx}}\right)^{1/2} + t_{c_2} \qquad [13]$$

If the degree to which thinning reduces C_{dmx} is given by η, then C_d is given by

$$C_d = C_{dmx}(1 - \eta)$$

Hence, equation [13] can be written as:

$$t_\eta = \Phi\left[(1 - \eta)\right]^{1/2} + t_{c_2} \qquad [14]$$

t = the time required to reach the reduced forest cover density as if the stand were initially patch-cut.

η = the degree that C_d is reduced from C_{dmx} (expressed as a decimal).

All of the time trend relationships are then initialized at t_η to simulate the hydrologic effects of selection cutting.

Subroutine TRENDS (Fig. 6).—This routine initially defines the time functions discussed above in terms of the boundary conditions supplied by Subroutine GBROUND. After each growing season, Subroutine TRENDS redefines the functions whenever necessary to incorporate the effects of time.

Subroutine GBOUND (Fig. 7).—Subroutine GBOUND is used to initialize the basic functions which comprise the time trends concept. These functions are expressed in terms of a wide variety

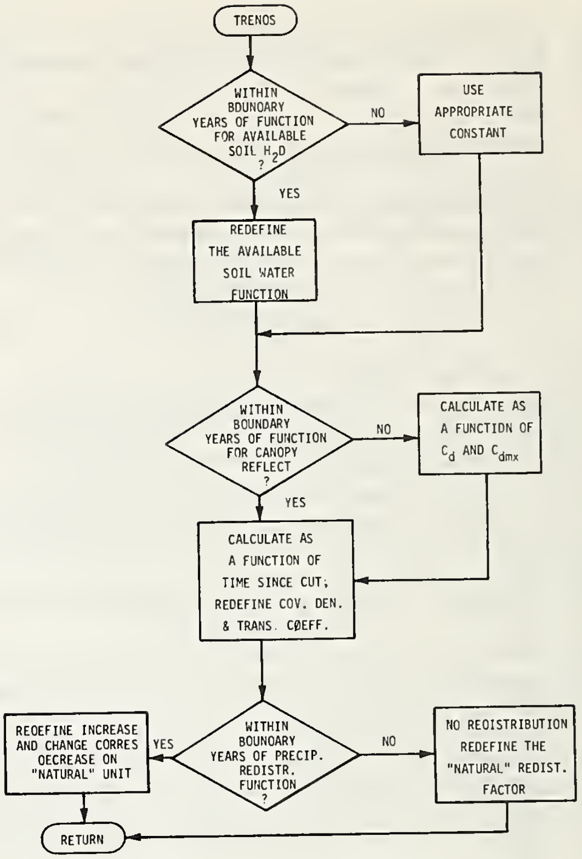


Figure 6.—Subroutine TRENDS.

of management practices. As trees regrow after cutting, the impact of the original removal is diminished until the hydrologic changes are no longer significant. Therefore, all parameters are specified in terms of the number of years following treatment (t_{cn}) when the effect of timber harvesting begins to diminish, and in terms of the number of years following treatment when hydrologic changes become negligible. If the parameters are not specified, the model assumes the values indicated in table 2, which vary according to vegetation type.

Subroutine GBOUND converts the boundary years into "real time" based on the year of treatment, and calculates the required parameters that are dependent solely on the boundary conditions.

Erosion and Sediment Yield

One of the environmental impacts associated with land use in the subalpine zone is erosion resulting from road construction. Accordingly, indices of onsite erosion and sediment yield downstream are

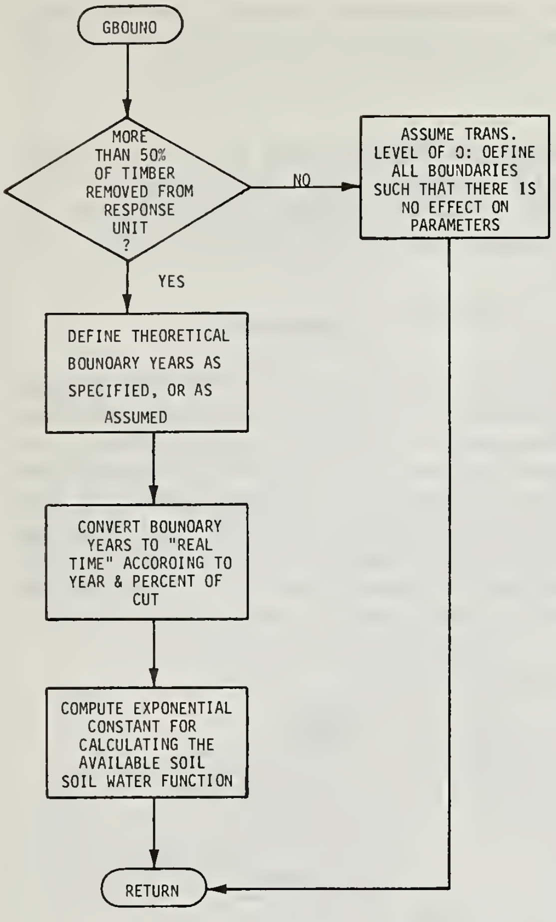


Figure 7.—Subroutine GBOUND.

computed by the Land Use Model. The erosion indices are computed from a system of empirical equations developed by Leaf (1974), based on field measurements of sediment yields in central Colorado (Leaf 1966, 1970, 1971), and a time trend equation proposed by Megahan (1974).

The model is based on measurements of accumulated sediment below a 1-square-mile experimental watershed. The sediment contained enough leaf litter and related organic debris so that the dry volumes of mineral soil occupied approximately 75 percent of the total volume of debris (dry unit weight approximately 85 lb/ft^3). Moreover, the data were obtained from a stable watershed (26 percent average slope) and a road system that was carefully constructed with a high standard of followup maintenance. Thus, although the equations may not be generally applicable throughout the Rocky Mountain Region, we believe they will serve as good first approximations of total sediment yield until more data become available.

Table 2.—Assumed boundary years for the time trend functions

Factor	Years before effect begins to diminish	Years until effect becomes negligible
Lodgepole pine		
Available soil water	15	80
Canopy reflectivity	0	40
Precipitation redistribution	40	120
Spruce-fir		
Available soil water	30	100
Canopy reflectivity	0	80
Precipitation redistribution	80	160
Aspen		
Available soil water	7	60
Canopy reflectivity	0	20
Precipitation redistribution	20	80

Sediment yields are expressed in terms of watershed characteristics, engineering design variables, and time. The equation for predicting cumulative onsite erosion is:

$$S = 0.12\ DEn \qquad [15]$$

where S = the total cumulative onsite erosion at time (t) after disturbance in ft^3.
D = the projected length of the disturbed area perpendicular to the road centerline in ft.
E = the unit cumulative onsite erosion at time (t) after disturbance in $ft^3/acre$.
n = the number of miles of road system.
$0.12 = 5{,}280 \frac{ft}{mi} \div 43{,}560 \frac{ft^2}{acre}$.

The projected length (D) is given by the equation

$$D = W \frac{W/2 \tan \nu}{\tan \Theta - \tan \nu} \qquad [16]$$

where W = the "effective" width of road in ft.
ν = steepness of the watershed sidelope in degrees.
$\Theta = \Theta_C = \Theta_F$ = the average angle of the cut and fill slopes in degrees.

The unit cumulative erosion (E) describes the erosion time trend, and can be expressed as

$$E = \epsilon_n t - S_o\ (e^{-k_2 t} - 1) \qquad [17]$$

where ϵ_n = an estimate of the long-term "normal" erosion rate on the undisturbed area in ft^3/acre. For central Colorado, (ϵ_n) is equal to 0.28 ft^3/acre based on 15 years of data collected from undisturbed watersheds.

S_0 = an index of the amount of soil available for erosion. This index is 201.3, based on statistical fitting to field measurements.

k_2 = an index of the rate of decline of erosion following disturbance, defined to be 0.085 by statistical fitting methods.

Sediment yields downstream expressed on a watershed basis are given by the equation

$$Q_s = \frac{S}{A} \qquad [18]$$

Equation [16] assumes balanced cut and fill (i.e., that the centerline bisects the road width). This is not usually the case, since the cross-section can vary from total cut to total fill in actual practice. However, we believe that a sufficiently accurate index of the total area disturbed can be obtained by estimating an "effective" width and average cut and fill slopes for the proposed road system. Such estimates require considerable judgment and a knowledge of the topography.

Three additional assumptions are behind equations [15] - [17]. First, it was assumed that the equations provide a better index of erosion than equations based on rainfall-derived erodibility indices. Such equations may be grossly in error, since they do not predict time trends, nor do they account for the effects of melting snow, which is responsible for much of the sediment yield from the subalpine zone in central Colorado. The second assumption was that onsite erosion is proportional to the area disturbed. Finally, it was assumed that the delivery ratio is constant for a given watershed size, regardless of the amount of area disturbed. These assumptions involve complex interactions between the hydrology, geology, and soil, which need to be verified by additional study.

Equation [18] is valid provided that the upstream drainage area does not exceed 1 square mile. Sediment yields at downstream points would be less, since delivery ratios are inversely related to watershed area. It should be noted that the model has not been programmed to compute delivery ratios for upstream areas greater than 1 square mile.

Because equations [15] - [18] describe sediment yields in terms of watershed slope and engineering design parameters, the land use planner has at least some latitude, subject to the limitations discussed above, in evaluating the potential short- and long-term impacts of alternative road systems required for various timber harvesting practices.

Subroutine SEDMOD (Fig. 8).—Equations [15] - [18] are appended to the Land Use Model as Subroutine SEDMOD. Program LUMOD provides the road design and sediment model parameters.

Applications

We have used the Land Use Model to simulate the long-term effects of forest and watershed management on the South Tongue River in the Bighorn National Forest (fig. 9). Elevations on the timbered portions of this drainage basin vary from approximately 8,000 to 8,900 ft. msl. Soils are derived from granitic rocks; virtually all of the forest cover is lodgepole pine. To illustrate how the model has been used, results from the analysis of

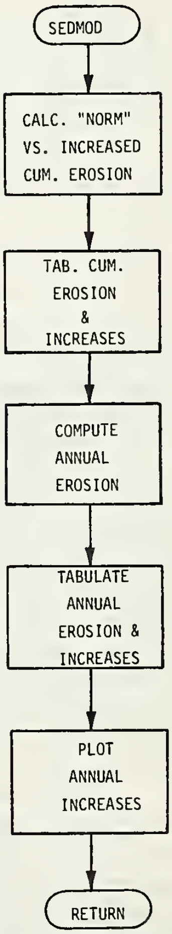


Figure 8.—Subroutine SEDMOD.

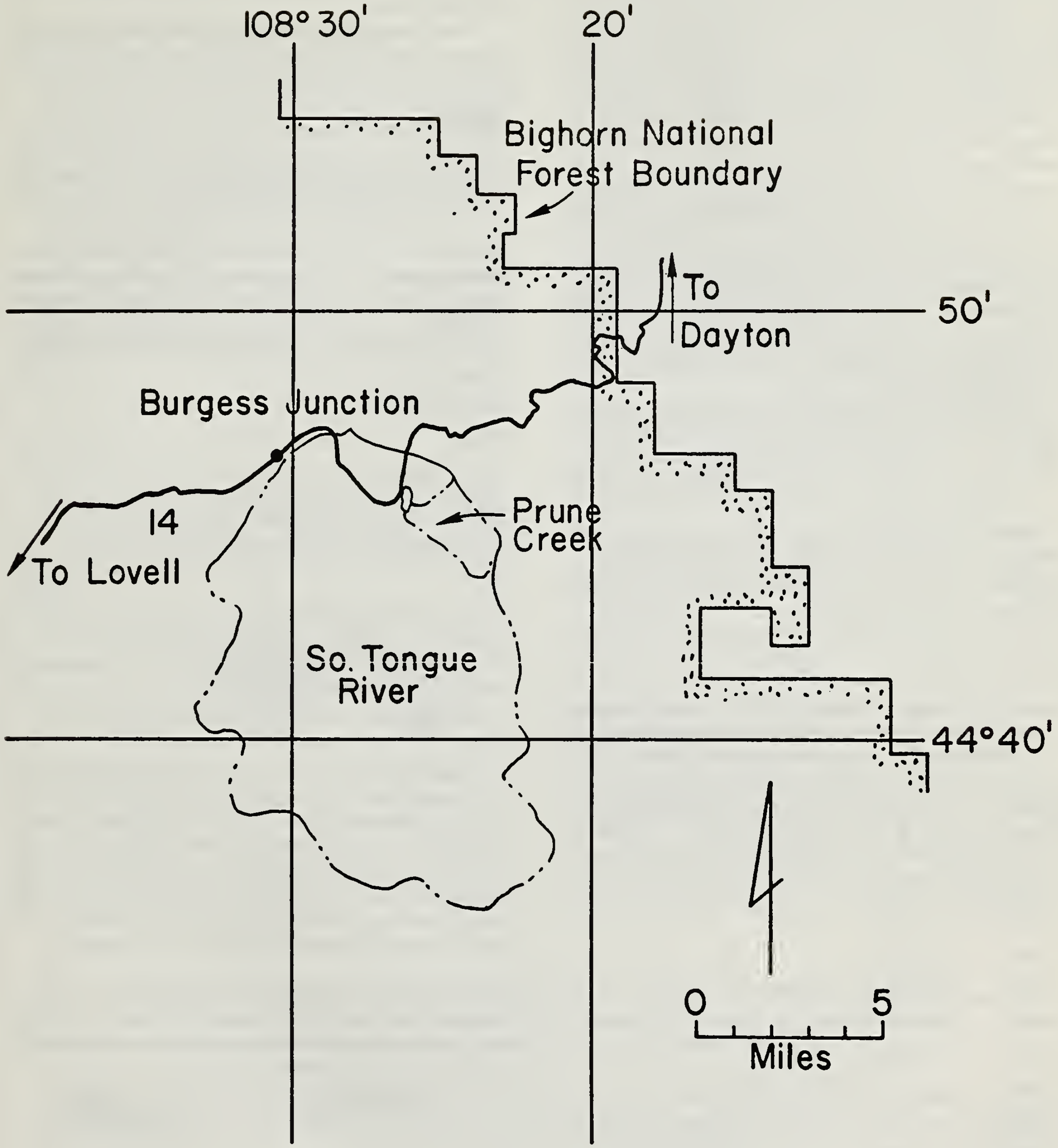


Figure 9.—Location map for South Tongue River, Bighorn National Forest.

one planning unit will be summarized here. Average values for pertinent geographic and hydrologic characteristics of a typical forested watershed in the South Tongue River drainage basin are:[3] area, 640 acres; elevation, 8,480 ft.; aspect, WSW; slope, 17%; C_{dmx}, 40%; peak snowpack water equivalent, 15.5 in.; annual precipitation, 29.6 in.; evapotranspiration, 15.8 in.; annual runoff, 13.8 in.

In addition to improving water yield, the management strategy selected for this example is compatible with wildlife habitat improvement and timber production. Under this strategy, the old-growth timber would be harvested so that approximately 40 percent of the planning unit area would be occupied by small openings — five to eight times tree height. Forest openings would be constructed in a balanced and unified pattern that is visually compatible with the natural landscape. The openings would be permanently maintained by clearing the natural reproduction at 30-year intervals after the initial patch-cut.

The remaining 60 percent of the planning unit area would be retained in continuous forest cover. However, trees would also be removed from this area on an individual tree basis at 30-year intervals so that the old-growth is gradually converted into a broad-aged stand.

The simulated management strategy essentially follows the recommendations published by Alexander (1972), which are keyed to stand descriptions, insect and disease problems, and windfall risk situations.

The management strategy would maintain a vigorous and productive forest cover throughout the planning interval.

[3]*Based on hydrologic simulation analyses of the effects of timber harvesting on Prune Creek, a 2,461-acre tributary of the South Tongue River (see fig. 9.).*

Table 3.—Projected changes in water yield resulting from timber harvesting, South Tongue River Planning Unit, Bighorn National Forest

Interval (Years)	Water yield increase, by treatment I	II	III	IV
	Inches			
0-10	+1.58			
11-20	+1.87			
21-30	+1.15			
31-40	+ .85	+1.59		
41-50	+ .71	+1.78		
51-60	+ .60	+1.54		
61-70	+ .38		+2.97	
71-80	+ .10		+2.41	
81-90	+ .04		+1.93	
91-100	- .05			+2.92
101-110	- .02			+2.75
111-120	- .01			+1.79

Runoff Increases

The diagram below illustrates the management strategy selected for this example:

Management strategy	Response unit (percent of planning unit area) 1 (40%)	2 (30%)	3 (30%)
Patch 1st yr.[1]	X		
Select 31st yr.[2]		X	
Clear[3]	X		
Select 61st yr.[2]		X	X
Clear[3]	X		
Clear 91st yr.[3]	X		
Select[2]			X

[1]*Forty percent of planning unit area occupied by openings 5 to 8 tree-heights in diameter.*
[2]*Individual-tree selection cut so that forest cover density (C_d) is reduced 50 percent.*
[3]*Clear regrowth from permanent openings.*

Projected 10-year mean runoff increases under this management strategy are summarized in table 3. The increases above the heavy diagonal line at any given time represent the overall response resulting from preceding management decisions. The data below the line reflect the singular effects of the initial patch-cut on 40 percent of the planning unit, as if it were the final decision in the strategy.

Water yields are improved throughout the planning interval, with the highest increases occuring after Treatment III. The projected runoff increases during each treatment interval are:

Treatment	Runoff increase
	Percent
I	11.1
II	11.9
III	17.7
IV	18.0

Apparently, the effect of the intial patch-cut persists for at least 60 and perhaps 70 years. Thereafter, the effect on water yield becomes negligible for all practical purposes.

Seasonal Distribution of Water Yields

The projected effects of the management strategy on distribution of water available for streamflow are summarized in table 4. These values represent increments of generated runoff, not routed streamflow. Hence, the effects of watershed storage must be considered in interpreting the data.

As seen in table 4, inputs from snowmelt are significantly increased during the April 16-30 and May 1-15 intervals, and decreased in June. Minor inputs to streamflow also occur in July, as compared to no input in the natural state, due to the less favorable hydrologic condition of the watershed.

Peak Flows

The hydrologic analysis in this example indicates that peak flows will be changed little if at all under the proposed management strategy. However, seasonal peaks would occur approximately 9 days earlier:

Treatment	Change in peak 7-day generated runoff	Change in timing
	Inches	*Days*
I	-0.2	-9
II	0	-9
III	+ .3	-9
IV	+ .4	-10

The projected overall effect of the proposed management strategy on runoff timing and peak flows would be to increase snowmelt and resultant streamflow in April and May. This accelerated input would enlarge early spring flows and cause the hydrograph to peak approximately 1 week earlier throughout the planning interval. Annual peak flows would not be increased, however, and runoff on the recession side of the hydrograph during the summer months may be slightly diminished.

Erosion and Sediment Yield

It is assumed that the proposed logging operation on the planning unit would require the equivalent of approximately 12 miles of road system, including all spur roads and landings. Because most of the disturbed area would be occupied by roads, it can be described in terms of road design variables, which have the following characteristics based on watershed side slopes averaging 17 percent:

"effective width" = 14 feet
average cut and fill slopes = 1½:1
width of disturbed area = 19 feet (from equation [16])
area disturbed per mile = 2.3 acres

The total area disturbed on the 1-square-mile planning unit is approximately 28 acres. For the purposes of this example, it is assumed that the entire road system would be constructed before logging operations on the planning unit. Thus most of the impact from road construction would take place during the first 30-year treatment interval.

The projected 10-year mean erosion increases produced by the proposed road system are summarized in table 5. Erosion on the 28 acres disturbed would increase 631 ft^3 above the untreated norm of 3.8 ft^3 immediately after the road construction, then decrease to less than 1 ft^3 above the norm after

Table 4.—Projected changes in distribution of water available for streamflow resulting from timber harvesting. South Tongue River Planning Unit, Bighorn National Forest

Runoff interval	Natural generated runoff	Average change in generated runoff, by treatment: I	II	III	IV
		Inches			
April 16-30	0.1	+0.9	+0.7	+1.2	+0.5
May 1-15	1.7	+2.1	+2.5	+2.2	+3.1
May 16-31	5.9	+ .6	+ .3	+ .5	+1.3
June 1-15	5.6	-3.0	-2.7	-2.5	-3.1
June 16-30	.7	- .4	- .3	- .5	- .5
July 1-15	0	+ .1	+ .1	+ .1	+ .1

90 years. It is expected that after the first 30 years, increased erosion would be one-fifth of that immediately after road construction. By 60 years, it would be one-seventieth. Ratios of increased erosion on the disturbed area to the norm before road construction for each 30-year treatment interval are tabulated below.

Treatment	Ratio
	(Increase/undisturbed norm)
I	43.4
II	3.4
III	.3
IV	.1

Although a 40-fold increase in on-site erosion appears high at first, it must be weighed against the typically minimal erosion on subalpine watersheds. Whether or not the increased erosion and sediment yield are excessive would depend on local requirements for water quality and fisheries. On Fool Creek, in central Colorado, no detrimental effects on the land resource or water quality were observed in spite of the fact that on-site erosion was increased by approximately a factor of 60 immediately after road construction. This empirical model is based on data obtained from a carefully constructed road system and a high standard of followup maintenance, however. Any application of the model in its present form should presume similar standards of construction and maintenance.

Conclusion

Validation of the Subalpine Land Use Model will require additional data on long-term responses. In the meantime, we believe that the output from the model will produce the type of information land use planners need in order to make difficult management decisions. The ability of the Subalpine Land Use Model and other similar models to integrate complex forest and water systems makes them unique and powerful tools for evaluating the hydrologic effects of a broad array of land-use schemes in the subalpine zone. A user's guide for the model follows in Appendix I. A complete listing of the model is summarized in Appendix II.

Table 5.—Projected increases[1] in on-site erosion resulting from road construction. South Tongue River Planning Unit, Bighorn National Forest

Interval (years)	Average erosion increase,[2] by treatment I	II	III	IV
	Cubic feet			
1-10	631			
11-20	270			
21-30	115			
31-40		49		
41-50		21		
51-60		9		
61-70			4	
71-80			2	
81-90			1	
91-100				<1
101-110				
111-120				

[1]*Assumptions:*
1. Area disturbed by road system = 28 acres.
2. Approximate unit weight of sediment = 85 lb/ft.^{3}.
[2]*Untreated norm = 3.8 ft^3.*

Literature Cited

Alexander, Robert R.
1972. Partial cutting practices in old-growth lodgepole pine. USDA For. Serv. Res. Pap. RM-92, 16 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Alexander, Robert R.
1974. Silviculture of central and southern Rocky Mountain forests: A summary of the status of our knowledge by timber type. USDA For. Serv. Res. Pap. RM-120, 36 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Hoover, Marvin D., and Charles F. Leaf.
1967. Process and significance of interception in Colorado subalpine forest. Internatl. Symp. For. Hydrol. p. 213-224. [Pa. State Univ., Univ. Park, Pa., Aug.-Sept., 1965] Proc. Edited by W. E. Sopper and H. W. Lull. XV plus 813 p. Pergamon Press-Oxford and New York.

Leaf, Charles F.
1966. Sediment yields from high mountain watersheds. U.S. Forest Serv. Res. Pap. RM-23, 15 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Leaf, Charles F.
1970. Sediment yields from Colorado snow zone. Am. Soc. Civil Eng., J. Hydraul. Div. Proc. Pap. 7006, 96(HY1): 87-93.

Leaf, Charles F.
1971. Closure. Sediment yields from Colorado snow zone. Am. Soc. Civil Eng., J. Hydraul. Div. Proc. Pap. 7006, 97(HY2):350-351.

Leaf, Charles F.
1974. A model for predicting erosion and sediment yield from secondary forest road construction. USDA For. Serv. Res. Note RM-174, 4 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Leaf, Charles F.
1975. Watershed management in the Rocky Mountain subalpine zone: the status of our knowledge. USDA For. Serv. Res. Pap. RM-137, (in press) Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Leaf, Charles F., and Glen E. Brink.
1972. Simulating effects of harvest cutting on snowmelt in Colorado subalpine forest. p. 191-196. *In* Watersheds in Transition Symp. [Fort Collins, Colo., June 1972] Proc. Serv. 14, 405 p. Am. Water Resour. Assoc., Urbana, Ill.

Leaf, Charles F., and Glen E. Brink.
1973a. Computer simulation of snowmelt within a Colorado subalpine watershed. USDA For. Serv. Res. Pap. RM-99, 22 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Leaf, Charles F., and Glen E. Brink.
1973b. Hydrologic simulation model of Colorado subalpine forest. USDA For. Serv. Res. Pap. RM-107, 23 p. Rocky Mt. For. and Range Exp. Stn., Fort Collins, Colo.

Megahan, Walter F.
1974. Erosion over time on severely disturbed granitic soils; a model. USDA For. Serv. Res. Pap. INT-156, 14 p. Intermt. For. and Range Exp. Stn., Ogden, Utah.

Miller, D. H.
1959. Transmission of insolation through pine forest canopy as it affects the melting of snow. Schweiz. Anst. f. Forst. Versuchsw. Mitt. 35: 57-79.

Muller, Robert A.
1971. Transmission components of solar radiation in pine stands in relation to climatic and stand variables. USDA For. Serv. Res. Pap. PSW-71, 13 p. Pac. Southwest For. and Range Exp. Stn., Berkeley, Calif.

Pollard, D. F. W.
1972. Above-ground dry matter production in three stands of trembling aspen. Can. J. For. Res. 2:27-33.

Reifsnyder, William E., and Howard W. Lull.
1965. Radiant energy in relation to forests. U.S. Dep. Agric., Agric. Handbook 445, 114 p.

APPENDIX I: USER'S GUIDE FOR SUBALPINE LAND USE MODEL

INTRODUCTION

This brief user's guide describes the input parameters necessary for the operation of the Subalpine Land Use Model (LUMOD). The parameter cards are discussed in the same order as that of the parameter card deck; thus, by preparing the cards in this step-by-step method, the deck will be in the proper order. The guide provides the card columns in which the parameter value is to be punched, as well as the format by which it is read. This guide is intended for use by those primarily concerned with application of the model; it does not provide any computer systems information and, therefore, is of limited value to programers or others who are computer-oriented.

The general flow of the model is as follows:

Step 1. Proofread the parameter card deck.

Step 2. Simulate the natural conditions from the climatological data (original data base.)

Step 3. Extend the original data base by randomly selecting years until the desired planning interval is reached.

Step 4. Simulate the management strategy from the extended data base.

Step 5. Repeat steps 2-4 for all planning units.

Step 6. Combine the planning units into a regional summary.

The following optional recovery procedures are provided:

1. The extended data base may be saved on a magnetic tape named "SAVNEW."

2. The results of the management strategy which are used in the regional summary are punched on cards in the event of abnormal termination. Thus, if one planning unit simulation had been successfully completed and the job aborted during the next planning unit, the RECOVERY DECK could replace the planning unit deck for the completed unit on the next run. This avoids recomputing an entire planning unit, but still provides results for use in the regional summary.

REGION CARDS

REGIONAL PARAMETERS

Card		Columns	Contents	Format
1	Identified by the word REGION.	1-6	"REGION"	A6
	The number of years to be simulated is generally the rotation cycle for a species; the original data base will be extended to the specified number by randomly selecting and repeating original years.	11-15	Number of years ($1 \leq n \leq 165$)	I5
	Initialize the random number generator with a positive number.	16-20	Seed for random number generator	I5
	If a magnetic tape is provided under the name SAVNEW, the extended data base is captured and saved for either recovery purposes or for use with other management strategies.	21-25	Save the extended data base? (0 = NO, 1 = YES, 2 = copy SAVOLD to SAVNEW before adding new files)	I5
	As the management strategy for a planning unit is completed, the information for the composite regional output is stored on the recovery deck in case the run terminates abnormally. Under normal termination, the recovery deck is not punched, but if specified, it may be punched regardless of the mode of termination.	26-30	Punch the recovery deck even under normal termination? (0 = NO, 1 = YES)	I5
	The five principal hydrologic components may be independently selected for regional summary output.	31	Print generated runoff? (0 = NO, 1 = YES)	I1
		32	" precipitation? " "	"
		33	" evapotranspiration? " "	"
		34	" change in storage? " "	"
		35	" change in W. E.? " "	"
2	The region ID may contain 80 characters of information.	1-80	Region identification	8A10

PLANNING UNIT DECK

PLANNING UNIT ID

Card		Columns	Contents	Format
3	The planning unit ID may contain 60 characters of descriptive information.	1-60	Planning unit identification	6A10
	A two-digit number may be included to identify the recovery files. (It is always appended to the year as a decimal on the files.)	61-62	Optional identification number	I2
	If the driving variable data are on magnetic tape SAVOLD (saved on a previous run), specify 14. Otherwise, specify 10. (Note: if a tape of card images is used rather than a DATA DECK, the tape ID must be UNEDIT). With a 14, the remaining cards for NATURAL CONDITIONS must be omitted, since only the management strategy simulation is to be done.	64-65	Input file (10 or 14)	I2
	Indicate the percent of the total region area represented by this planning unit. (.15 = 15%)	66-68	Area Weight	F3.2
	If results are wanted at the planning unit level, specify the types of output. The codes are as follows (note 1,2&3 are available only as indicated):	69	Print detailed natural conditions? (0,1)	I1
		70	" list of years in extended data base? (0,1)	"
		71	" detailed managed conditions? (0,1)	"
		72	" list of time variant conditions? (0,1)	"
	0 - Not wanted	73	" generated runoff? (0,1,2,3)	"
	1 - Print the results	74	" precipitation? "	"
	2 - Print and plot only the differences attributable to the management strategy	75	" evapotranspiration? "	"
		76	" change in storage? "	"
		77	" change in W. E. "	"
	3 - Both 1 and 2.	78	" Bimonthly generated runoff? (0,2)	"
		79	" Peak W. E. and date? (0,2)	"
		80	" 7-day peak R.O. and starting date? (0,2)	"

NATURAL CONDITIONS

Card		Columns	Contents	Format
4	Identified by the words: SUBSTATION CONSTANTS	1-20	"SUBSTATION CONSTANTS"	2A10
	Transmissivity Coefficient: (If left blank, the model will supply a value as a function of the forest canopy density.)	21-25	Transmissivity Coefficient	F5.2

Estimate the decimal percent of the solar radiation reaching the canopy which is transmitted (allowed to pass through) to the snowpack and/or understory. The following table summarizes combinations of cover densities and transmissivity coefficients which were found acceptable during the calibration of the model in lodgepole pine and spruce-fir forest in central Colorado:

COVER DENSITY	TRANSMISSIVITY COEFF
0.00 (open)	1.00
.25	.45
.30, .35	.40
.40	.35
.45	.30
.55, .65	.25

	Columns	Contents	Format
Cover Density: Using the above table as a guide, estimate the forest canopy density as a decimal percent. (In the table, the values below 50 were for lodgepole pine, with those above 50 for spruce-fir.)	26-30	Cover Density	F5.2
Maximum Cover Density: Normally, this value is the same as number 5. But if a reduction in cover density is desired, this variable will allow adjustments to be made in the evapotranspiration and energy balance to compensate for that reduction.	31-35	Maximum Cover Density	F5.2
Vegetation Type - Indicate the forest canopy composition as lodgepole pine, spruce-fir, or deciduous.	40	1 = lodgepole, 2 = spruce-fir, 3 = deciduous	I1
Reflectivity Threshold Temperature: The model assumes that fresh snowfall increases the snowpack reflectivity according to internally controlled functions. However, field experience has shown that it is not necessarily increased during snow events where the daily maximum temperature varies according to aspect and elevation. The table below indicates some station characteristics and corresponding reflectivity threshold temperatures.	41-45	Reflectivity Threshold	F5.0

Card		Columns	Contents	Format
4	Relative Elevation / Aspect / °F. (see below)			

Relative Elevation	Aspect	°F.
High	North, East	32
Low-Middle	East	40
Low-Middle	North	45
All ranges	West	45
Low	South	60
Middle-High	South	70

Card		Columns	Contents	Format
	Melt Threshold Temperature - During initial snowpack accumulation, the model relies on a base temperature to stop melt when the mean daily temperature is below that base. A knowledge of the typical pattern of fall snow accumulation will guide the user in selecting a threshold temperature. Areas where the snowpack accumulates and melts frequently might indicate a low threshold (32°F.). High thresholds (40°-45°F.) may be assumed where the snowpack may yield some melt, but generally continues to build once started.	46-50	Melt Threshold	F5.0
	Available Soil Water - Estimate the soil mantle recharge requirement at which water is no longer available for transpiration. Examples: -5.3; -7.8; -10.6 inches.	51-55	Available Soil Water	F5.2
	Deciduous Winter Values - The values defined in items 4, 5, and 6 represent the foliated conditions of a deciduous forest. Corresponding values must be supplied for the defoliated state and must represent the reduction in cover density between the seasons. The values used most frequently for cover density and maximum cover density on aspen stands in the central Rockies were .35 and .20 for the foliated and defoliated states, respectively. The model was allowed to generate the transmissivity coefficients as a function of those cover densities.	56-60 61-65 66-70	Deciduous Winter trans. coeff " " cov. den. " " max. cov. den.	F5.2 F5.2 F5.2
	Latitude - Select 38°, 40°, 42°, or 44°	72-73	Latitude (38,40,42, or 44)	I2
	Aspect - Leave blank for a horizontal surface, or select N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW, OR NNW	75-77	Aspect (Left-justified)	A3
	Slope - Leave blank for a horizontal surface, or select 10%, 20%, 30%, or 40%	79-80	Slope (10,20,30, or 40)	I2
5	Identified by the words INITIAL CONDITIONS, this card provides these conditions on Oct 1 of the first water year:	1-20	"INITIAL CONDITIONS"	2A10
	Initial Snowpack Temperature, °C.	21-25	Snowpack Temperature	F5.2
	Initial Snowpack Water Equivalent, inches	26-30	Snowpack Water Equivalent	F5.2
	Initial Recharge Requirement, inches	31-35	Recharge Requirement	F5.2
6	Identified by the words: DAILY ET	1-10	"DAILY ET"	A10
	Average Daily Evapotranspiration - Obtain estimates of the average daily potential evapotranspiration in inches for each month.	21-25 26-30 31-35 ° ° ° 76-80	Average daily ET for Jan " " " " Feb " " " " Mar " " " " Dec	F5.2 " " "
7	Identified by the words AIR TEMP COEFF + ADJ	1-20	"AIR TEMP COEFF + ADJ"	2A10
	Air Temperature Correlation Coefficients - Supply the correlation coefficients for predicting the daily extreme temperatures in °F. from a base station, where the coefficients A and B are of the form, $T_{subunit} = A + B(T_{base})$ If the entire basin is being considered as a unit with observed extremes available, the coefficients would be 0.0 and 1.0, respectively. Examples: Maximum A = 4.779 B = 0.907 Minimum A = 0.698 B = 1.023	21-25 26-30 31-35 36-40	A_{MAX} B_{MAX} A_{MIN} B_{MIN}	F5.3 " " "
	Specify a post-peak precip adjustment, if desired. Example 1.15 = 15% increase.	41-45	Post-peak precip adjustment	F5.3

Card		Columns	Contents	Format
8	Identified by the word: FORMAT	1-6	"FORMAT"	A6
	Specify the format for reading a data card. All six input items (month, day, year, max temp, min temp, and precip.) must be read by F formats. Read the date variables by F2.0	7-70	Variable Format (include parenthesis)	6A10,A4
	Specify the file number (or data deck number) if more than one set of data is included.	72-73	File number on "UNEDIT"	I2
	Specify the relative order on the card for the month.	75	Relative order for month	I1
	" " " " " " " " " day.	76	" " " day	"
	" " " " " " " " " year.	77	" " " year	"
	" " " " " " " " " max temp.	78	" " " max temp	"
	" " " " " " " " " min temp.	79	" " " min temp	"
	" " " " " " " " " precip.	80	" " " precip	"
	Example: If the items were ordered year, month, day, precip, temp max, and temp min, the relative order would be 231564.			
9	Identified by the words: SPECIFIED CONDITIONS. Include one card for each water year to be simulated.	1-20	"SPECIFIED CONDITIONS"	2A10
	Specify the observed peak water equivalent.	21-25	Observed peak water equivalent	F5.2
	Specify the date of the observed peak W.E.	32-37	Date of peak W.E. (MMDDYY)	3I2
	Specify the date by which the pack must be isothermal.	39-44	Isothermal date (MMDDYY)	3I2
10	Identified by the words: END OF NATURAL COND.	1-20	"END OF NATURAL COND."	2A10

MANAGEMENT STRATEGY

Note: The results from simulating natural conditions prescribed by the above cards are used repeatedly in simulating each of the management plans which make up the management strategy. Thus, the above cards are included only once, and each step (management plan) in the management strategy is described on a card as explained below. The cards which comprise the strategy are collectively termed the management strategy deck.

Card		Columns	Contents	Format
11a	Timber harvesting, Identified by the words: MANAGEMENT PLAN	1-20	"MANAGEMENT PLAN"	2A10
	A 1-5 digit non-zero response unit (managed area) number must be supplied. If more than one area is to be managed, unique numbers (not necessarily sequential) must be assigned to each of them.	21-25	Response unit number	I5
	Specify the year of initial timber harvest	28-30	Year of cut	I3
	Specify the percent of the total planning unit area represented by this response unit. (.15 = 15%)	31-35	Area weight	F5.0
	Specify the percent of the area of the response unit which is subjected to timber harvesting. 1.00 implies a complete removal of forest cover and the canopy will be reestablished with time; .99-.51 implies a partial removal of forest cover with the canopy being reestablished with time; and .50-.01 implies a reduction in the forest cover which does not permit an increase in canopy density subsequent to the initial cut.	36-40	Percent cut	F5.0

Note: If all of the boundary conditions below are left blank, the assumed values for each of the hydrologic functions will be used. The boundaries are expressed in terms of the number of years since the initial cut. The lower boundary is the number of years that the cut area retains the characteristics of an opening if patch-cut, and the upper boundary is the required number of years before the cut area reacts as it did under natural conditions.

Card		Assumed Years: lodge-pole	spruce-fir	aspen	Columns	Contents	Format
	Soil Water, Lower	15	30	7	43-45	Lower boundary, soil water function	I3
	Upper	80	100	60	48-50	Upper " , " " "	I3
	Cover Density, Lower	0	0	0	53-55	Lower " , cover density function	I3
	Upper	40	80	20	58-60	Upper " , " " "	I3
	Precip Redist, Lower	40	80	20	63-65	Lower " , precip redist. "	I3
	Upper	120	160	80	68-70	Upper " , " " "	I3
	Max increase due to precip redist. (An increase in precipitation of .30 would correspond to 5-8H patches which occupy 40% of the planning unit. In this situation, the snowpack is increased 30% in the openings and decreased 20% in the uncut forest. For other combinations of opening size and area, the redistribution factor should be adjusted accordingly.)	0.0	0.0	0.0	71-75	Max increase due to precip redist.	F5.0
	If a desired cover density is known, rather than a percent cut (col 36-40), specify the desired cover density and the model will calculate the percent cut.				76-80	Desired cover density (col 36-40 must be blank if this is included)	F5.0

Card		Columns	Contents	Format
11b	Weather modification, Identified by the words: MANAGEMENT PLAN	1-20	"MANAGEMENT PLAN"	2A10
	There is no response unit number since cloud seeding affects the entire planning unit.	21-25	Must be blank	
	Specify the year cloud seeding begins.	28-30	Year cloud seeding begins	I3
	Specify the year cloud seeding ends.	33-35	Year cloud seeding ends	I3
	Specify the month and day that cloud seeding starts in a given year.	37-40	Date seeding starts (MMDD)	2I2
	Specify the month and day that cloud seeding ends in a given year.	42-45	Date seeding ends (MMDD)	2I2
	Specify the percent increase in precip due to cloud seeding	46-47	Percent increase	F5.0

ROAD CONSTRUCTION

Card		Columns	Contents	Format
12	Identified by the words: ROAD CONSTRUCTION Note: The road construction card should contain the same year as a management plan.	1-20	"ROAD CONSTRUCTION"	2A10
	If a road construction card (or more than one) is included, the sediment yield model will execute. There are no options on its output, so if it is not wanted, exclude road construction cards.			
	Specify the year of construction.	28-30	Year of construction	I3
	Specify the 1) number of miles of road system	31-35	Miles of road	F5.0
	2) "effective" width of the road	36-40	Effective width of road	"
	3) index of the normal rate of erosion	41-45	Index, normal rate	"
	4) index of the soil available for erosion	46-50	Index, available soil	"
	5) index of the rate of decline of erosion	51-55	Index, rate of decline (positive number)	"
	6) average slope of the cut expressed as tan θ_C (.20 = 20%)	56-60	Slope of cut	"
	7) average slope of the fill expressed as tan θ_F (.20 = 20%)	61-65	Slope of fill	"
	8) average watershed sideslope on which the road is constructed	66-70	Slope of planning unit	"
13	Identified by the words: END OF STRATEGY	1-15	"END OF STRATEGY"	A210

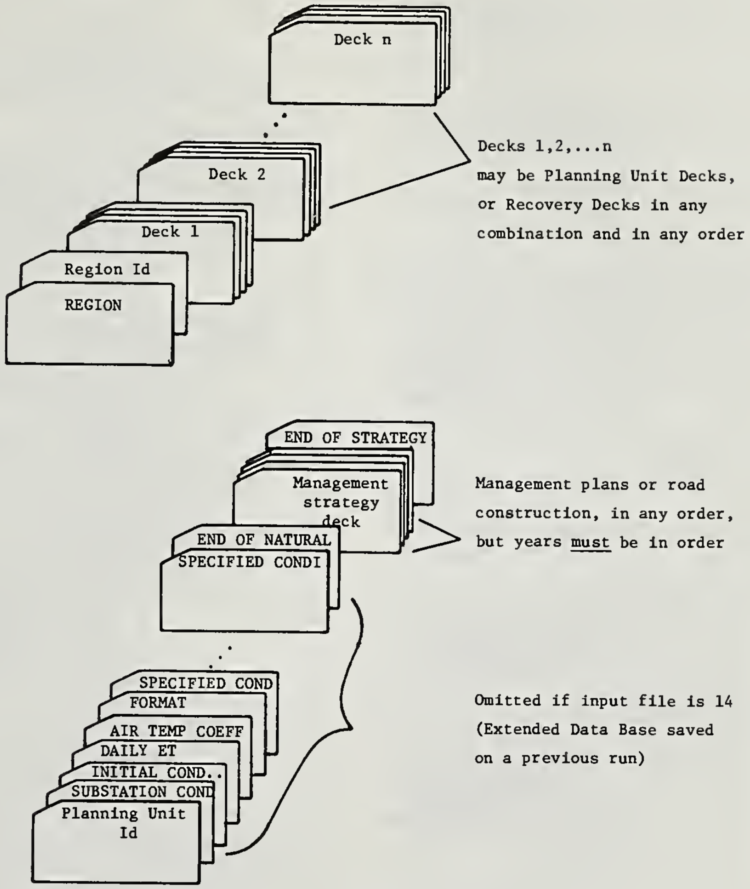
Note: The following are the limitations of the management strategy deck:

1. The cards must all be in order by the year specified in col 28-30. There may be more than one card for any given year, and within that year, no particular order is mandatory. For example, in year 75, the management strategy may require road construction (1 card) and two response units (2 cards). All 3 cards would have year 75.

2. A maximum of 7 separate response units may be designated. However, an existing response unit may be reentered any number of times, within a limit of 11 individual managemental strategies.

3. A maximum of 11 separate roads may be constructed.

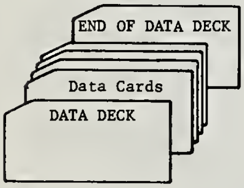
PARAMETER DECK ORDER



DATA DECK

The climatological data may be read from cards, if the card is preceded by a card containing the words: "DATA DECK" in columns 1-9, and terminated by a card containing the words: "END OF DATA DECK" in columns 1-16. This deck may appear anywhere in the parameter deck following the region cards (cards 1 & 2).

DATA DECK ORDER



RECOVERY DECK

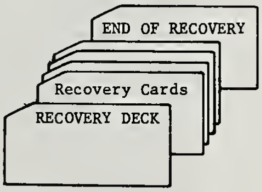
In the event that a recovery deck is to be run, the recovery deck for any given planning unit may be identified from the punched output by one of the following methods:

1. Columns 5 and 6 contain the optional 2-digit ID discussed on the planning unit ID, or if not specified,

2. Column 37 will contain a 1, 2, 3, 4, or 5. There will be one card for each year in group 1, group 2, etc. Therefore, the end of the recovery deck in question will be the last card in the 5 group.

The deck must be preceded by a card containing the words: "RECOVERY DECK" in columns 1-13 and terminated by a card containing the words: "END OF RECOVERY DECK" in columns 1-20. (If the area weight is to be changed, punch the new weight in cols. 66-68 of the RECOVERY DECK card; otherwise, leave those columns blank.) The recovery deck replaces all cards pertaining to the planning unit in the parameter card deck (Planning unit deck.)

RECOVERY DECK ORDER



Program LUMOD

```
      OVERLAY (OLAYS,0,0)
      PROGRAM LUMOD (INPUT=512,OUTPUT=512,DATFIL=65,PLNFIL=65,
     1 PLNLST=512,PROOFD=65, PUNCH=512,SAVNEW=513,SAVOLD=513,SCRFIL=65,
     2 TIMFIL=512,UNEDIT=512,TAPE5=INPUT,TAPE6=OUTPUT,TAPE10=UNEDIT,
     3 TAPE11=DATFIL,TAPE12=PLNFIL,TAPE13= PUNCH,TAPE14=SAVOLD,
     4 TAPE15=SAVNEW,TAPE16=SCRFIL,TAPE17=TIMFIL,TAPE18=PLNLST,
     5 TAPE19=PROOFD)
C-----THIS IS THE CONTROLLING ROUTINE OF THE LAND USE PLANNING MODEL FOR
C----- THE SUBALPINE ZONE (WATER, TIMBER, SOIL)
C-----
C-----THE FILE BUFFER SIZES ARE LIMITED ABOVE TO SAVE MEMORY.  THOSE
C----- WHICH HANDLE FORMATTED READS AND WRITES ARE ALLOWED ABOUT HALF OF
C----- THEIR NORMAL BUFFER, BUT THOSE WHICH ARE ACCESSED ONLY BY BUFFER
C----- IN AND BUFFER OUT ARE LIMITED TO THE MINIMUM BUFFER SIZE
C-----
C-----THE REGION FILE (-RNGFIL-) WAS CHANGED TO THE PUNCH FILE (-PUNCH-)
C----- TO PROVIDE RECOVERY DECKS IN CASE OF ABNORMAL TERMINATION.  BY
C----- OPTION, THE USER MAY CAUSE THE DECX TO BE PUNCHED EVEN UNDER
C----- NORMAL TERMINATION, BUT IF THE OPTION IS NOT SPECIFIED, THE FILE
C----- IS REWOUND AND AN END OF FILE IS WRITTEN WHEN TERMINATING
C----- NORMALLY
C-----
C-----SEDIMENT YIELD, AN INDEPENDENT SIMULATION MODEL, HAS BEEN INCLUDED
C----- WITHIN THE GENERAL FLOW OF THE LAND USE MODEL.  HOWEVER, THE ONLY
C----- FUNCTION THAT IS PERFORMED BY THE LAND USE MODEL FOR SEDIMENT
C----- MODELING IS THAT OF PROOFREADING AND INPUT OF PARAMETERS.  ALL
C----- ROUTINES OF THE LAND USE MODEL WHICH WERE MODIFIED CONTAIN THE
C----- COMMON BLOCK /S/ (EXCEPT THIS MAIN PROGRAM WHICH CONTAINS THE
C----- DICTIONARY DEFINITIONS OF THE VARIABLES LISTED IN COMMON BLOCK
C----- /S/).  THE SEDIMENT MODEL ITSELF IS A SECONDARY OVERLAY WHICH IS
C----- LOADED AND EXECUTED BETWEEN THE EXECUTION OF THE MANAGEMENT
C----- SIMULATION AND THE PRINTING OF THE COMPOSITE PLANNING UNIT OUTPUT
C-----
C-----DICTIONARY
C      AIRTMC - THE MEAN AIRTEMPERATURE IN DEGREES CENTIGRADE
C      ALLOW = 0, DO NOT ALLOW ANY INTERCEPTION
C            = 1, INTERCEPTION ALLOWED
C      ALTYR - YEAR OF MANAGEMENT PLAN ON GIVEN RESPONSE UNIT
C      AVSOIL - SEDIMENT MODEL, AN INDEX OF THE AMOUNT OF SOIL AVAILABLE
C                    FOR EROSION
C      BIMNTH - ARRAY FOR ACCUMULATING BIMONTHLY TOTALS FOR GENERATED
C                    RUNOFF DURING THE SNOWMELT SEASON
C      BLOCK - DATA ARRAY FOR TRANSFER OF ONE ENTIRE YEAR TO AND/OR FROM
C                    TAPE FILES
C                    (1) - YEAR AND ID, YY.ID
C                    (2) - (373) - MAXIMUM TEMPERATURE
C                    (374) - (745) - MINIMUM TEMPERATURE
C                    (746) - (1117) - ACCUMULATED PRECIPITATION
C                    (1118) - (1489) - INCIDENT SHORTWAVE RADIATION
C                    (1490) - (1861) - ENERGY ADJUSTED EVAPOTRANSPIRATION
C                    (1862) - TRANSMISSIVITY COEFFICIENT
C                    (1863) - COVER DENSITY
C                    (1864) - MAXIMUM COVER DENSITY
C                    (1865) - VEGETATION TYPE
C                    (1866) - REFLECTIVITY THRESHOLD
C                    (1867) - MELT THRESHOLD
C                    (1868) - WILTING POINT
C                    (1869) - DECIDUDUS WINTER TRANSMISSIVITY COEFFICIENT
C                    (1870) - DECIDUOUS WINTER COVER DENSITY
C                    (1871) - DECIDUOUS WINTER MAXIMUM COVER DENSITY
C                    (1872) - SPECIFIED ISOTHERMAL DATE (PSEUDO-JULIAN)
C                    (1873) - SPECIFIED PEAK WATER EQUIVALENT DATE (PSEUDO
C                    JULIAN)
C                    (1874) - INITIAL WATER EQUIVALENT
C                    (1875) - INITIAL RECHARGE REQUIREMENT
C                    (1876) - YEARLY TOTAL GENERATED RUNOFF
C                    (1877) - YEARLY TOTAL EVAPOTRANSPIRATION
C                    (1878) - CHANGE IN RECHARGE REQUIREMENT OVER THE
C                    WATER YEAR
C                    (1879) - CHANGE IN THE SNOWPACK WATER EQUIVALENT OVER
C                    THE WATER YEAR
C                    (1880) - APRIL 16-30 GENERATED RUNOFF
C                    (1881) - MAY 1-15 GENERATED RUNOFF
C                    (1882) - MAY 16-31 GENERATED RUNOFF
C                    (1883) - JUNE 1-15 GENERATED RUNOFF
C                    (1884) - JUNE 16-30 GENERATED RUNOFF
C                    (1885) - JULY 1-15 GENERATED RUNOFF
C                    (1886) - ACTUAL PEAK WATER EQUIVALENT
C                    (1887) - ACTUAL PEAK WATER EQUIVALENT DATE (PSEUDO-
C                    JULIAN)
C                    (1888) - PEAK 7-DAY GENERATED RUNOFF
C                    (1889) - DATE OF FIRST DAY OF PEAK 7-DAY GENERATED
C                    RUNOFF
C      BOUND - THE BOUNDARIES ON THE TIME FUNCTIONS
C                    (1) - NUMBER OF YEARS BEFORE REGROWTH BEGINS TO
C                    INCREASE SOIL WATER USE
C                    (2) NUMBER OF YEARS WHEN REGROWTH IS COMPLETE AS FAR
C                    AS SOIL WATER USE IS CONCERNED
C                    (3) - NUMBER OF YEARS BEFORE REGROWTH BEGINS TO ALTER
C                    THE COVER DENSITY AND CANOPY REFLECTIVITY
C                    (4) - NUMBER OF YEARS WHEN REGROWTH IS COMPLETE AS
C                    FAR AS CANOPY REFLECTIVITY IS CONCERNED
C                    (4) - NUMBER OF YEARS BEFORE REGROWTH BEGINS TO ALTER
C                    THE PRECIP REDISTRIBUTION FACTORS
C                    (6) - NUMBER OF YEARS WHEN REGROWTH IS COMPLETE AS
C                    FAR AS PRECIP REDISTRIBUTION IS CONCERNED
C      CALDEF - THE CALORIE DEFICIT IS THE NUMBER OF CALORIES NEEDED
C                    TO BRING THE SNOWPACK TEMPERATURE TO ZERO DEGREES
C                    CENTIGRADE (NOTE SHOULD BE MADE THAT IS IS A POSITIVE
C                    QUANTITY)
C      CANREF - THE FACTOR FOR ADJUSTING THE EVAPOTRANSPIRATION FOR
C                    CANOPY DENSITY (RECOMPUTED EACH YEAR UNDER THE
C                    MANAGEMENT STRATEGY TO INCORPORATE THE EFFECTS OF
C                    REGROWTH)
C      COMAX - MAXIMUM COVER DENSITY ON THE PLANNING UNIT
C      COMAX2 - HALF OF -COMAX-.  USED AS THE CRITICAL POINT IN SELECTION
C                    CUTTING TO DETERMINE WHETHER OR NOT THE WATER BALANCE
C                    ROUTINES ARE TO BE ALTERED BY THE TIME TRENDS
C      CHANGR - CHANGE IN THE RECHARGE REQUIREMENT OVER THE WATER YEAR
C      CHANGW - CHANGE IN THE SNOWPACK WATER EQUIVALENT OVER THE WATER
C                    YEAR
C      CONAV - THE TIME DEPENDENT CONSTANT FOR ADJUSTING EVAPOTRANSPIRA-
C                    TION FOR AVAILABLE SOIL WATER (RECOMPUTED EACH YEAR
C                    UNDER THE MANAGEMENT SIMULATION TO INCORPORATE THE
C                    EFFECTS OF REGROWTH)
C      COVDEN - THE COVER DENSITY IS THE FRACTION OF THE GROUND OR SNOW
C                    SURFACE SHADED FROM DIRECT SUNLIGHT OR RADIATION
C      CUT - THE PERCENT OF THE COVER DENSITY REMOVED (0.0 THROUGH 1.0).
C                    SEE -SPECCD-
C      DATE - MONTH, DAY
C      DATES - SAME AS -DATE- BUT FOR TWO DATES
C      DATIME - DATE AND TIME OF RUN IN ALPHANUMERIC FORMAT AS FOLLOWS
C                    MM.DD.YY  HH.MM.SS.
C      DCOMAX - THE WINTER VALUE FOR -COMAX- ON DECIDUOUS FORESTS
C      DECIDS - AN ARRAY USED IN WORKING WTIH DECIDUOUS FORESTS FOR
C                    RETAINING THE COVER DENSITY, MAXIMUM COVER DENSITY
C                    AND TRANSMISSIVITY COEFFICIENT FOR ONE SEASON WHILE
C                    THE OTHER IS BEING PROCESSED.  (IN OTHER WORDS, WHILE
C                    OPERATING DURING THE SUMMER, THE WINTER VALUES ARE
C                    STORED.  LIKEWISE, IN THE WINTER, THE SUMMER VALUES
C                    ARE STORED.  LOCATION 1 IS FOR THE TRANSMISSIVITY
C                    COEFFICIENT, 2 IS FOR THE COVER DENSITY AND 3 IS FOR
C                    THE MAXIMUM COVER DENSITY)
C      DECLIN - SEDIMENT MODEL, AN INDEX OF DECLINE OF EROSION FOLLOWING
C                    DISTURBANCE
C      DECMAL - OPTIONAL TWO DIGIT INTEGER WHICH IDENTIFIES THE FILES ON
C                    -SAVNEW-.  EACH PLANNING UNIT MAY BE GIVEN AN ID
C                    WHICH IS THEN APPENDED AS A DECIMAL TO THE YEAR IN
C                    EACH BLOCX OF THE FILE.  THE NUMBERIC VALUE THUS
C                    BECOME YY.ID
C      DREADY = 0, DIFFUSION MODEL (SUBROUTINE DIFMOD) NOT INITIALIZED
C             = 1, DIFFUSION MODEL INITIALIZED AND READY FOR SNOWPACK
C                    TEMPERATURE SIMULATION
C             = -1, DIFFUSION MODEL MAY NOT BE USED
C      ETDALY - ARRAY OF DAILY AVERAGE EVAPOTRANSPIRATION FOR EACH MONTH
C      ETFROM = 1, EVAPORATION IS FROM THE CANOPY
C             = 2, EVAPORATION IS FROM THE SURFACE OF THE SNOWPACK
C             = 3, BOTH 1 AND 2
C             = 4, EVAPOTRANSPIRATION IS FROM SNOWMELT, RAIN OR THE
C                    SOIL MANTLE STORAGE
C      ETO - ARRAY OF POTENTIAL EVAPOTRANSPIRATION VALUES (ALREADY
C                    ADJUSTED FOR SLOPE, ASPECT, ETC) FOR AN ENTIRE YEAR
C      EVAPTR - WHEN FIRST RECEIVED, THIS VARIABLE IS THE POTENTIAL
C                    EVAPOTRANSPIRATION AS COMPUTED BY THE HAMON METHOD
C                    AND ADJUSTED FOR AVAILABLE RADIATION.  AFTER ACTION
C                    IS TAKEN BY THE WATER BALANCE ROUTINES, THE ORIGINAL
C                    VALUE HAS BEEN ADJUSTED FURTHER BY THE METHODS
C                    DISCUSSED IN SUBROUTINES CANVAP, EVTRAN, AND SNOWVAP.
C                    IT THEN REPRESENTS THE EVAPOTRANSPIRATION DURING THIS
C                    INTERVAL
C      EXPK - THE -K- FROM THE TIME FUNCTION FOR COMPUTING THE AVAILABLE
C                    SOIL WATER ADJUSTMENT FACTOR
C      EXPK1 - THE -K1- FROM THE TIME FUNCTION FOR COMPUTING THE PRECIP
C                    REDISTRIBUTION FACTOR
C      FORNXT - A UTILITY ARRAY WHOSE ONLY PURPOSE IS FOR READING AND
C                    WRITING CURRENT MODEL CONDITIONS ON THE SCRATCH
C                    FILE.  IT IS EQUIVALENCED WITH THE ENTIRE COMMON
C                    BLOCK /M/.  SEE -L4NXT-
C      FRACTN -THE FRACTIONAL PART NEEDED IN THE INTERPOLATION BETWEEN
C                    TABLE VALUES IN THE COMPUTATION OF THE RADIATION
C      GENRO - DAILY GENERATED RUNOFF
C      INFILE = 10, DATA IS ON FILE -UNEDIT-.  SEE -NFILE-
C             = 14, DATA IS ON FILE -SAVOLD- IN STANDARD MODEL FORMAT
C      ISOTRM - THE MANDATORY ISOTHERMAL DATE (NOTE, MUST BE IN THE
C                    CALENDAR YEAR WICH CORRESPONDS TO THE WATER YEAR.
C                    THAT IS, IT MUST BE BETWEEN JAN 1 AND SEP 30)
C      LAST1 - RETAINS THE OLD VALUE OF -NEXTYR- WHEN A NEW ONE IS READ
C      LCOPY - ARRAY FOR COPYING LINES FROM ONE FILE TO ANOTHER
C      LINES - LINE COUNTER
C      NAME - AN ALPHANUMERIC IDENTIFIER USED PRIMARILY TO VERIFY THE
C                    PARAMETER CARD ORDER.  ALSO USED IN ARRAY FORM AS
C                    IDENTIFIERS FOR THE PRINTOUTS DURING THE PLANNING
C                    UNIT AND REGION PHASES
C      NDAY - THE PSEUDO JULIAN WATER YEAR DATE (1 = OCT 1)
C      NEXTYR - THE YEAR ON THE NEXT MANAGEMENT PLAN
C      NFILE - THE NUMBER OF THE FILE ON -UNEDIT- WHICH CONTAINS THE DATA
C                    FOR THIS PLANNING UNIT
C      NPLAN - THE NUMBER OF THIS PLAN IN THE SEQUENCE MAKING UP THE
C                    MANAGEMENT STRATEGY
C      NRMANG - A SWITCH INDICATING THE MODE OF OPERATION (0 OR 1 IS FOR
C                    THE NORMAL SIMULATION, 2 FOR MANAGEMENT)
C      NROADS - SEDIMENT MODEL, THE NUMBER OF TIMES ROADS WERE
C                    CONSTRUCTED DURING A MANAGEMENT STRATEGY PERIOD
C      NSAVED - NUMBER OF FILES WRITTEN ON -SAVNEW- DURING THE RUN
C      NUM - THE RESPONSE UNIT CODE ON THE NEXT MANAGEMENT PLAN
C      NUNIT - THE NUMBER OF RESPONSE UNITS AT ANY GIVEN POINT IN TIME
C      NYEARS - NUMBER OF YEARS FOR MANAGEMENT STRATEGY (IF THE ORIGINAL
C                    DATA BASE DOES NOT HAVE THIS NUMBER OF YEARS, IT WILL
C                    BE EXPANDED OR CONTRACTED AS NEEDED)
C      PARAM - AN ARRAY OF PARAMETERS READ FROM THE MANAGEMENT PLAN CARD
C                    (1) - RESPONSE UNIT WEIGHT
C                    (2) - PERCENT CUT
C                    (3) - (8) - CORRESPONDS TO -BOUND(1) - (6)-
C                    (9) - MAXIMUM INCREASE IN PPT DUE TO REDISTRIBUTION
C      PEAKED = 0, THE PEAK WATER EQUIVALENT HAS NOT BEEN REACHED
C             = 1, THE PEAK WATER EQUIVALENT HAS BEEN REACHED
C      PEAKRO - THE YEARLY 7 DAY PEAK RUNOFF
C      PEAKWE - THE YEARLY PEAK WATER EQUIVALENT
C      PEKDAT - THE SPECIFIED PEAK WATER EQUIVALENT DATE
C      PEKPPT - THE OBSERVED ACCUMULATED PRECIPITATION ON THE SPECIFIED
C                    PEAK WATER EQUIVALENT DATE
C      PHISQ - PHI SQUARED, USED IN THE TIME FUNCTIONS FOR COVER DENSITY
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```
C                   AND CANOPY REFLECTIVITY
C       PLNOPT - ARRAY OF OUTPUT OPTIONS FOR PLANNING UNIT PHASE (0 = NO
C                   OUTPUT, 1 = PRINT OUTPUT)
C                   (1) - DETAILED YEARLY OUTPUT FOR NORMAL SIMULATION
C                   (2) - LIST OF YEARS IN ORIGINAL DATA BASE AND THOSE
C                         GENERATED DURING EXTENSION OF THAT DATA BASE
C                   (3) - DETAILED YEARLY OUTPUT FOR MANAGEMENT
C                         SIMULATION
C                   (4) - LIST OF CHANGES MADE BY THE TIME TRENDS
C                         FUNCTIONS
C                 SUMMARIES FOR PLANNING UNIT (0=NO OUTPUT, 1=ACTUAL
C                 TOTALS, 2=DIFFERENCES AND PLOT OF DIFFERENCES,
C                 3=BOTH 1 AND 2)
C                   (5) - GENERATED RUNOFF
C                   (6) - PRECIPITATION
C                   (7) - EVAPOTRANSPIRATION
C                   (8) - CHANGE IN RECHARGE REQUIREMENT
C                   (9) - CHANGE IN SNOWPACK WATER EQUIVALENT
C                   (10)-(15) - BIMONTHLY GENERATED RUNOFF DIFFERENCES
C                 AND PLOTS (0=NONE WANTED, 2 IN (10) IMPLIES ALL)
C                   (16)-(17) - SNOWPACK PEAK WATER EQUIVALENT AND DATE,
C                 DIFFERENCES AND PLOTS (0=NEITHER WANTED, 2 IN I16)
C                 IMPLIES BOTH)
C                   (18)-(19) - PEAK 7-DAY GENERATED RUNOFF AND STARTING
C                 DATE, DIFFERENCES AND PLOTS (0=NEITHER WANTED, 2
C                 IN (19) IMPLIES BOTH)
C       PLUNIT - 60 CHARACTER NAME AND/OR DESCRIPTION OF THE PLANNING UNIT
C       POTENT - ARRAY OF POTENTIAL INCIDENT SHORTWAVE RADIATION VALUES AT
C                   APPROXIMATELY TWO WEEK INTERVALS THROUGH THE YEAR
C       POTRAD - THE INTERPOLATED VALUE SELECTED FROM -POTENT-
C       PPT - ARRAY OF ACCUMULATED PRECIPITATION FOR THE ENTIRE YEAR
C       PPTNOW - THE OBSERVED ACCUMULATED PRECIP UP TO THE DAY BEING
C                   PROCESSED
C       PRECIP - DAILY PRECIPITATION AMOUNT
C       PREWEQ - PREDICTED SNOWPACK WATER EQUIVALENT
C       RAD - ARRAY OF THE RADIATION (ALREADY ADJUSTED FOR SLOPE, ASPECT,
C                   ETC.) FOR THE ENTIRE YEAR
C       RADIN - RADIATION IN IS THE TOTAL INCIDENT SHORT WAVE RADIATION
C       RADLWN - NET LONG WAVE RADIATION IS THE ALGEBRAIC SUM OF THE LONG
C                   WAVE RADIATION FROM THE FOREST AND THE LONG WAVE
C                   RADIATION LOST BY THE SNOWPACK TO THE CANOPY
C       RADSUB - SUBSCRIPT USED IN THE CALCULATION OF -POTRAD-
C       RADSWN - THE CALORIC INPUT TO THE PACK BY THE NET SHORT WAVE
C                   RADIATION
C       RATNRM - SEDIMENT MODEL, AN ESTIMATE OF THE LONG-TERM NORMAL
C                   EROSION RATE
C       RCHRGO - THE RECHARGE REQUIREMENT AT THE BEGINNING OF THE WATER
C                   YEAR
C       RDIST - THE FACTOR FOR REDISTRIBUTING THE PRECIP
C       RDMAX - THE MAXIMUM INCREASE IN PRECIP DUE TO REDISTRIBUTION
C       RECHRG - RECHARGE REQUIREMENT OR SOIL MANTLE STORAGE DEFICIT
C       RECOVR = 0, DO NOT PUNCH RECOVERY DECKS UNDER NORMAL TERMINATION
C                1, PUNCH RECOVERY DECKS EVEN UNDER NORMAL TERMINATION
C       REGION - 80 CHARACTER NAME AND/OR DESCRIPTION OF REGION
C       REGOPT - ARRAY OF OUTPUT OPTIONS FOR REGIONAL PHASE (0 = NO
C                   OUTPUT, 1 = PRINT OUTPUT)
C                 SUMMARIES FOR REGIONAL PHASE
C                   (1) - GENERATED RUNOFF
C                   (2) - PRECIPITATION
C                   (3) - EVAPOTRANSPIRATION
C                   (4) - CHANGE IN RECHARGE REQUIREMENT
C                   (5) - CHANGE IN SNOWPACK WATER EQUIVALENT
C       REGROW(1,-) - SEE -CONAV-
C             (2,-) - SEE -CANREF-
C       RO - ARRAY OF DAILY GENERATED RUNOFF FOR AN ENTIRE YEAR
C       ROADMI - SEDIMENT MODEL, THE NUMBER OF MILES OF ROAD CONSTRUCTED
C       ROADW - SEDIMENT MODEL, THE EFFECTIVE WIDTH OF THE ROAD
C       RUNUM - THE RESPONSE UNIT CODES
C       RUWT - THE PERCENT OF THE PLANNING UNIT REPRESENTED BY EACH
C                   RESPONSE UNIT
C       SAVE = 0, DO NOT SAVE THE EXTENDED DATA BASE
C            = 1, SAVE THE EXTENDED DATA BASE ON -SAVNEW-.  (NOTE,
C                   -SAVNEW- IS NOT POSITIONED FOR THE SAVING OF THE FILE
C                   WITHIN THE RUN - THE USER MUST REWIND OR POSITION IT
C                   BEFORE EXECUTION.  THE LIST AT THE END OF THE RUN
C                   WILL INCLUDED ALL FILES CURRENTLY ON -SAVNEW-)
C            = 2, SAME AS 1 EXCEPT ALL OF THE FILES FROM -SAVOLD- ARE
C                   COPIED TO -SAVNEW- AFTER THE PROOFREADING PHASE AND
C                   BEFORE THE EXECUTION PHASE
C       SEDINC -THE PERCENT INCREASE IN PRECIP DUE TO CLOUD SEEDING
C       SEDRN2 - SEED FOR RANDOM NUMBER GENERATOR, USED IN EXTENDING THE
C                   ORIGINAL DATA BASE TO A SPECIFIED NUMBER OF YEARS
C       SEEDAT - THE DATES OF CLOUD SEEDING (MMDD THROUGH MMDD)
C       SEEDYR - THE YEARS OF CLOUD SEED
C       SEEDYR - THE YEARS OF CLOUD SEEDING (Y1 THROUGH Y2)
C       SIMTM1 - AN ARRAY USED PRIMARILY IN SUBROUTINE DIFMOD IN THE
C                   SIMULATION OF THE AVERAGE SNOWPACK TEMPERATURE
C       SLPASP - THE SLOPE/ASPECT ADJUSTMENT FACTORS FOR TRANSLATING THE
C                   VALUES IN -POTENT- TO THE INDIVIDUAL STATION
C       SPECCO - IF THE MANAGEMENT PLAN SPECIFIES A COVER DENSITY RATHER
C                   THAN A PERCENT CUT (SEE -CUT-), THE MODEL WILL
C                   CALCULATE THE PERCENT OF THE COVER DENSITY THAT MUST
C                   BE REMOVED TO ACHIEVE THE SPECIFIED COVER DENSITY
C       SUMMER - THE POST-PEAK PRECIPITATION ADJUSTMENT FACTOR (EXPRESSED
C                   AS A DECIMAL PERCENT OF THE SUMMER BASE STATION
C                   PRECIP.  EXAMPLE 1.05)
C       TANCUT - SEDIMENT MODEL, THE SLOPE OF THE CUT IN ROAD CONSTRUCTION
C                   AS A PERCENT
C       TANFIL - SEDIMENT MODEL, THE SLOPE OF THE FILL IN ROAD
C                   CONSTRUCTION AS A PERCENT
C       TANRHO - SEDIMENT MODEL, THE AVERAGE SLOPE AS A PERCENT ON WHICH A
C                   ROAD IS CONSTRUCTED
C       TCOEFF - THE TRANSMISSIVITY COEFFICIENT USED TO ESTIMATE THE NET
C                   SHORT WAVE RADIATION REACHING THE SNOWPACK
C       TMAX - ARRAY OF DAILY MAXIMUM TEMPERATURES FOR AN ENTIRE YEAR
C       TMIN - ARRAY OF DAILY MINIMUM TEMPERATURES FOR AN ENTIRE YEAR
C       TMPMAX - THE MAXIMUM TEMPERATURE DURING THE INTERVAL IN DEGREES
C                   FARENHEIT
C       TMPMIN - THE MINIMUM TEMPERATURE DURING THE INTERVAL IN DEGREES
C                   FARENHEIT
C       TMPMLT - THE TEMPERATURE BELOW WHICH THE FALL RADIATION ROUTINE
C                   MAY NOT CREATE MELT OR FREE WATER
C       TYPCUT = 0, THIS TYPE OF CUT DOES NOT HAVE REDISTRIBUTION
C                   ASSOCIATED WITH IT
C              = 1, THIS TYPE OF CUT HAS REDISTRIBUTION ASSOCIATED WITH IT
C       VARFMT - VARIABLE FORMAT FOR READING FROM FILE -UNEDIT-
C       VARIN - INPUT ARRAY TO BE READ BY -VARFMT- (ALLOWS THE VARIABLES
C                   TO BE IN ANY ORDER AT INPUT TIME)
C       VEGTYP = 1, FOREST COVER PREDOMINATELY LODGEPOLE PINE
C              = 2, FOREST COVER PREDOMINATELY SPRUCE-FIR
C              = 3, FOREST COVER PREDOMINATELY ASPEN (DECIDUOUS)
C              = 4, INTERNAL USE ONLY TO SPECIFY DEFOLIATED DECIDUOUS
C                   FORESTS (DURING THE WINTER)
C       WATRIN - THE SUM OF ANY SNOWMELT AND ANY RAIN WHICH PROVIDES
C                   DIRECT INPUT TO THE WATER BALANCE
C       WE - ARRAY OF DAILY PACK WATER EQUIVALENTS FOR AN ENTIRE YEAR
C       WEIGHT - THE PERCENT OF THE REGION AREA REPRESENTED BY THIS
C                   PLANNING UNIT (A DECIMAL PERCENT BETWEEN 0.0 AND 1.0)
C       WEO - THE SNOWPACK WATER EQUIVALENT AT THE BEGINNING OF A WATER
C                   YEAR
C       WILTPT - THE WILTING POINT
C       YEAR - CURRENT YEAR BEING PROCESSED
C       YRCNST - SEDIMENT MODEL, YEAR OF ROAD CONSTRUCTION
C       YRTOT - ARRAY OF THE YEARLY ACCUMULATED VALUES OF THE CONTINUITY
C                   EQUATION
C-----
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
C-----PROOFREAD THE CARD DECK
      CALL OVERLAY (5HOLAYS,7,0)
C-----IF SPECIFIED, COPY -SAVOLD- TO -SAVNEW-
      IF(SAVE.EQ.2) CALL OVERLAY (5HOLAYS,3,0)
C-----READ A PLANNING UNIT CARD
   20 READ (19) PLUNIT,DECMAL,INFILE,WEIGHT,PLNOPT
C-----AT THE END OF FILE, PROCESS THE REGIONAL FILE
      IF(EOF(19)) 80,30
C-----IF -INFILE- IS 14, THE NORMAL SIMULATION AND EXPANDED DATA FILE
C----- WERE SAVED FROM A PREVIOUS RUN.  FIND THE FILE ON -SAVOLD- AND
C----- IF IT HAS THE SPECIFIED NUMBER OF YEARS, COPY IT TO -DATFIL- AND
C----- JUMP DIRECTLY TO THE MANAGEMENT PLANS SIMULATION.  OTHERWISE,
C----- COPY IT TO -SCRFIL- AND JUMP TO CREATE THE SPECIFIED NUMBER OF
C----- YEARS
   30 IF(INFILE - 14) 50,40
   40 CALL OVERLAY (5HOLAYS,1,0)
      IF(NRMANG) 70,60
C-----PROCESS THE NORMAL SIMULATION AND GENERATE THE ORIGINAL DATA FILE
   50 NRMANG = 1
   60 CALL OVERLAY (5HOLAYS,2,0)
C-----PERFORM THE MANAGEMENT PLANS SIMULATION
   70 NRMANG = 2
      CALL OVERLAY (5HOLAYS,2,0)
C-----SUMMARIZE THE RESULTS FOR THIS PLANNING UNIT AND GO ON TO THE NEXT
      CALL OVERLAY (5HOLAYS,4,0)
      GO TO 20
C-----REGIONAL SUMMARY
   80 CALL OVERLAY (5HOLAYS,5,0)
      IF(RECOVR) 100,90
   90 REWIND 13
      END FILE 13
C-----IF ANY FILES WERE SAVED, LIST THEM
  100 IF(SAVE.NE.0) CALL OVERLAY (5HOLAYS,6,0)
C-----TERMINATE THE RUN
      END
```

Subroutine GDATE

```
      SUBROUTINE GDATE (NDAY,DATE)
C-----CONVERT THE PSEUDO-JULIAN DATE TO MONTH AND DAY
      INTEGER DATE(2),MONTHS(12)
      DATA MONTHS/10,11,12,1,2,3,4,5,6,7,8,9/
      DATE(2) = MOD(NDAY,31)
      IF(DATE(2)) 10,20
   10 DATE(1) = MONTHS((NDAY/31)+1)
      RETURN
   20 DATE(2) = 31
      DATE(1) = MONTHS(NDAY/31)
      RETURN
      END
```

Subroutine GETREC

```
      SUBROUTINE GETREC (IFILE,ARRAY,N,IEND)
C-----READ A RECORD
      DIMENSION ARRAY(1)
      BUFFER IN (IFILE,1) (ARRAY(1),ARRAY(N))
      IF(UNIT(IFILE)) 10,20,30
C-----OK TO PROCEED
   10 IEND = 0
      RETURN
C-----END OF FILE
   20 IEND = 1
      RETURN
C-----PARITY ERROR
   30 WRITE (6,910) IFILE
  910 FORMAT(*0PARITY ERROR ON FILE*I3,* WHILE READING - JOB ABORTED*)
      CALL ABORT
      END
```

Subroutine PUTREC

```
      SUBROUTINE PUTREC (IFILE,ARRAY,N)
C-----WRITE A RECORD
      DIMENSION ARRAY(1)
      BUFFER OUT (IFILE,1) (ARRAY(1),ARRAY(N))
      IF(UNIT(IFILE)) 10,10,20
   10 RETURN
   20 WRITE (6,910) IFILE
  910 FORMAT(*0PARITY ERROR ON FILE*I3,* WHILE WRITING - JOB ABORTED*)
      CALL ABORT
      END
```

Program GETOLD

```
      OVERLAY (OLAYS,1,0)
      PROGRAM GETOLD
C-----GET THE DATA FILE FROM -SAVOLD-
      COMMON DATIME(2),DECMAL,NRMANG,NSAVEO,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGIDN(B),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECDVR,REGION,REGOPT,SAVE,SEORN2
      DIMENSION BLOCK(1889),ID(9)
      CALL CORE (-1)
      JEND =
C-----PREPARE THE DATA FILE AND GET AN IO RECORD
   10 CALL GETREC (14,IG,9,IEND)
C-----IF THE END OF FILE WAS READ, CHECK TO SEE IF A COMPLETE PASS HAS
C----- BEEN MADE OR IF THE FILE SHOULD BE REWOUNO AND SEARCHED AGAIN
      IF(IEND) 20,90
   20 REWIND 14
      IF(JEND) 30,80
   30 WRITE (6,910) PLUNIT
  910 FORMAT(*CTHE PLANNING UNIT CARD ENTITLED *6A10/*  INDICATES THE EX
     1PANDED DATA FILE WAS CREATED AND SAVED ON AN OLD RUN.  HOWEVEP, AS
     2 THE LIST BELOW INDICATES,*/*  ND SUCH FILE EXITS ON -SAVDLO-*/)
      IFILE = 0
   40 CALL GETREC (14,ID,9,IEND)
      IF(IEND) 70,50
   50 IFILE = IFILE + 1
      WRITE (6,920) IFILE,(ID(I),I=1,6)
  920 FORMAT(* SAVOLD FILE*I3,5X6A10)
C---BYPASS THE DATA
   60 CALL GETREC (14,BLOCK,1889,IEND)
      IF(IEND) 40,6D
   70 WRITE (6,930)
  930 FORMAT(*0JOB ABDRTED*)
      CALL ABDRT
   BC JEND = 1
      GD TO 10
C-----IF THIS IS NDT THE OESIRED FILE, BYPASS THE DATA
   9D DO 1DO I = 1,6
      IF(PLUNIT(I).NE.ID(I)) GO TO 11D
  1D0 CDNTINUE
      GD TD 120
  11D CALL GETREC (14,BLOCK,1889,IEND)
      IF(IEND) 10,110
C-----THIS IS THE FILE.  IF IT HAS THE SAME NUMBER OF YEARS AS IS
C----- CURRENTLY BEING PROCESSED, JUST COPY IT TO THE EXPANOEO OATA FILE
C----- AND RETURN.  BUT IF IT HAS A DIFFERENT NUMBER OF YEARS, COPY IT
C----- TO THE SCRATCH FILE FOR EXPANSION OR CONTRACTION
  120 IF(NYEARS - IO(7)) 13D,140
  130 NRMANG = 0
      IFILE = 16
      GD TO 150
  140 NRMANG = 2
      IFILF = 11
  150 REWIND IFILE
      GO TO 170
  16D CALL PUTREC (IFILE,BLOCK,1889)
  170 CALL GETREC (14,BLOCK,1B89,IEND)
      IF(IEND) 1BD,160
  1B0 END FILE IFILE
      CALL CORE (D)
C-----RETURN TO THE PRIMARY OVERLAY
      END
```

Program LOADS

```
      OVERLAY (DLAYS,2,0)
      PRDGRAM LOADS
C-----THIS OVERLAY CONTAINS THE WATER BALANCE ANO UTILITY ROUTINES SO
C----- THCY ARE AVAILABLE FOR EITHER THE NORMAL OR THE MANAGEMENT
C----- SIMULATION AND IT CALLS FOR THE LOAOING OF THE APPROPRIATE
C----- PERIPHERAL RDUTINES
      COMMON DATIME(2),DECMAL,NRMANG,NSAVEO,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECDVR,REGION(B),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGEP OATIME,PLNOPT,PLUNIT,RECDVR,REGION,REGOPT,SAVE,SEORN2
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RAOLWN,PAOSWN,TMPMAX,TMPMIN,WATRIN
      COMMON/S/AVSOIL(11),OECLIN(11),NROAOS,RATNRM(11),ROAOMI(11),
     I ROADW(11),TANCUT(11),TANFIL(11),TANRHO(11),YRCNST(11)
      INTEGER YPCNST
      COMMON/TIME/CANREF,COMAX2,CONAV
      COMMON/UTILTY/BLOCK(1B89),CHANGR,CHANGW,OATE(2),OATES(4),LINES,
     1 NAME,NOAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGEP DATF,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAO(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLO),IBLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCDMAX),(BLOCK(1B72),
     4 ISOTRM),(BLOCK(1873),PEKDAT),IBLOCK(1B80),BIMNTH(1)),
     5 (BLOCK(1B86),PCAKWE),(BLOCK(188B),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      NROADS = 0
      N = NRMANG
      IF(N.EQ.0) N = 1
      CALL OVERLAY (5HOLAYS,2,N)
      IF(NROADS.NE.0) CALL OVERLAY (5HOLAYS.2,3)
C-----RETURN TO THE MAIN OVERLAY
      END
```

Subroutine WATBAL

```
      SUBROUTINE WATBAL (F1,F2,F3,I1,F4,F5,I2,I3,F6,I4,F7,F8,F9,F10,F11,
     1 F12,F13,F14,I5,F15)
C-----THIS SUBROUTINE IS THE MAIN ROUTINE OF THF WATER BALANCE MODEL. IT
C----- RECEIVES THE ORIVING, STATIC AND CONTINUOUS VARIABLES FROM THE
C----- OPERATING ROUTINES, CONTROLS THF COMPUTATIONS ON THEM, AND
C----- RETURNS THE NEW VALUES FOR THE CONTINUOUS VAPIABLES AND THF
C----- RESULTS OF THIS INTERVAL.  SEE THE REPLACEMENT STATEMENTS BELOW
C----- FOR THE VARIABLE OEFINITIONS OF THE PARAMETERS
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,CDMAX,COVON,OREDY,ENGBL,
     1 ENGBLO,FIFLOC,FREWT,LSUSD,NDSNO,DNTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER DPEDY,PHASE,VEGTYP
      COMMON/WTPBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      DATA AVETMC,BASTMF,ENGBL,SMTM3/D.0,35.0,-1.0,0.D/
C-----OBTAIN THE STATION OESCRIPTORS
      COVDN = F3
      CDMAX = F2
      FIELOC = -F15
      TCOEF = F12
      TMPMLT = F13
      TRSHLO = F14
      VEGTYP = I5
C-----RECALL THE CDNTINUDUS VARIABLES NECESSARY FOR THE OPERATIDN OF THE
C----- MODEL DURING THIS INTERVAL
      CALDF = F1
      OREDY = I1
      ENGBLO = F4
      FREWT = F5
      LSUSD = I2
      NOSNO = I3 + 1
      ONTRE = F6
      PHASE = I4
      PREWE = F7
      RCHRG = F8
      IF(OREDY) 20,2D,10
   10 SMTMI(1) = F9
      SMTM1(2) = F10
      SMTM1(3) = F11
C-----AVETMC = (((TMPMAX-32)+(TMPMIN-32))/2)*(5/9)
   20 AVETMC = (TMPMAX + TMPMIN - 64.D) * D.2777777778
C-----STAPT THE ENERGY BALANCE ANO THE INPUT AT ZERO FOR THIS INTERVAL
      ENGBL = 0.C
      WATRIN = 0.0
C-----IF THERE IS NO PRECIP, THERE IS NO NEEO TO PASS THROUGH THE
C----- CLASSIFICATION STATEMENTS
      IF(PRECIP) 90,90,30
C-----SEE IF THE PRECIP IS ALL SNOW
   30 IF(TMPMIN.LE.32.0.OR.TMPMAX.LT.BASTMF) GO TO BO
C-----SEE IF ANY OF IT IS SNOW
      IF(TMPMIN - BASTMF) 40,50,50
   40 CALL MIXTUR
      GO TO 90
C-----THIS IS A RAIN EVENT.  IF THERE IS NO PACK, THE RAIN IS DIRECT
C----- INPUT TO THE WATER BALANCE.  BUT IF THERE IS A PACK, OETERMINE
C----- THE EFFECTS OF THE RAIN
   5D IF(PREWE) 6C,60,70
   60 WATPIN = PRECIP
      GO TO 13C
   70 CALL RAINEO (AVETMC,PRECIP)
      GO TO 90
C-----THIS IS A SNOW EVENT
   BO CALL SNOWEO (AMIN1 IAVETMC,0.0),PRECIP)
C-----IF THERE IS SNOW ON THE TREES, EVAPORATE ONLY FROM THE CANOPY
   90 IF(ONTRE) 130,130,I00
  I00 CALL CANVAP
C-----ON THE FIRST OAY AFTER FRESH SNOW, ASSUME TURBULENCE HAS REMOVEO
C----- ANY REMAINING INTERCEPTEO SNOW ANO AOOEO IT TO THE PACK
      IF(NDSND - 1) 12C,110,110
  11D PREWE = PREWE + ONTRE
      ONTRE = 0.0
C-----IF THERE IS NO SNOWPACK, BYPASS THE RAOIATION ROUTINES
  I20 IF(PREWE) 190,19D,180
C-----OETERMINE THE FOREST TYPE - CONIFEROUS OR OECIOUOUS
  130 IFIVEGTYP.NE.3.ANO.VEGTYP.NE.4) GO TO I35
C-----OECIDUOUS
      CALL OECID
      GO TO 200
C-----CONIFEROUS - OETERMINE WHETHER TO SATISFY THE EVAPOTRANSPIRATION
C----- REOUIREMENTS UNOER GROWING SEASON OR WINTER CONOITIONS
  I35 IFIPREWE) 16D,160,14D
  140 IF(PREWE - 5.0) 150,15C,170
C-----USE THE GPOWING SEASON ROUTINES TO INCLUOE TRANSPIRATION
  150 CALL RADBAL
C-----A00 -WATRIN- TO THE RECHARGE REQUIREMENTS SO THE ET RDUTINE CAN
C----- OPEPATE ON THE INPUT AS WELL AS THE STORAGE
  160 RCHRG = RCHRG + WATRIN
C-----0.22388 = 0.15/0.67 (SEE THE COMMENT IN SUBROUTINE EVTRAN FOR THE
C----- USE OF THE CONSTANT)
      CALL EVTRAN (0.22388)
      GO TO 20C
C-----USE THE WINTER ROUTINES TO EVAPORATE FROM THE SNOWPACK SURFACE
  170 CALL SNOVAP
  18C CALL RAOBAL
C-----ADO -WATRIN- TO THE RECHARGE/REQUIREMENTS
  I90 RCHRG = RCHRG + WATRIN
C-----IF THE RECHARGE PEOUIREMENTS WERE SATISFIEO, THE EXCESS IS
C----- CONSIOERED TO BE GENERATEO RUNOFF
  200 IF(RCHPG) 220,22C,210
  21C GENRO = RCHRG
      F8 = 0.0
      GO TO 230
  220 GENRO = 0.0
      FB = RCHRG
  230 I1 = DREDY
      F1 = CALOF
      F4 = ENGBL
      F5 = FREWT
      I2 = LSUSD
      I3 = NDSNO
      F6 = ONTRF
      F7 = PREWE
C-----WHEN THE PACK IS GONE, RESET THE PHASE INDICATOR
      IF(PREWE) 240,240,250
  240 I4 = 0
      RETURN
  25C I4 = PHASE
      IF(DREDY) 270,270,260
  260 F9 = SMTM1(1)
      F10 = SMTM1(2)
      FII = SMTM1(3)
  27C RETURN
      ENO
```

Subroutine CALIN

```
      SUBROUTINE CALIN (CALRIN)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF THE CALORIC INPUT ON THE
C----- SNOWPACK
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVON,OREDY,ENGBL,
     1 ENGBLO,FIELOC,FREWT,LSUSD,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER OREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RADLWN,RAOSWN,TMPMAX,TMPMIN,WATRIN
C-----ADD THESE CALORIES INTO THE ENERGY BALANCE
      ENGBL = ENGBL + CALRIN
C-----SEE IF A CALORIE OEFICIT EXISTS IN THE PACK
      COMPAR = CALRIN - CALOF
      IF(COMPAR) 10,20,30
C-----THERE IS A CALORIE DEFICIT, BUT THE INPUT OIO NOT COMPLETELY
C----- WIPE IT OUT.  ALL OTHER CONOITIONS ARE UNCHANGEO
   10 CALOF = - COMPAR
      RETURN
C-----THE CALORIE OEFICIT WAS WIPEO OUT, BUT ALL OTHER CONOITIONS ARE
C----- UNCHANGEO
   20 CALOF = 0.0
      RETURN
C-----ANY DEFICIT WHICH OIO EXIST WAS WIPEO OUT.  COMPUTE THE POTENTIAL
C----- MELT FROM THE REMAINING CALORIES (CALORIES/(80.0 * 2.54))
   30 POTMLT = COMPAR/203.2
      CALOF = 0.0
C-----IF THE INPUT WAS ENOUGH TO MELT THE WHOLE PACK, CONTRIBUTE THE
C----- WATER EOUIVALENT TO THE SNOWMELT ANO ZERO ALL CONOITIONS
      IF(POTMLT.LT.PREWE-FREWT) GO TO 40
      WATRIN = WATRIN + PREWE
      PREWE = 0.0
      FREWT = 0.0
      RETURN
C-----OEPLETE THE ICE PACK BY THE AMOUNT MELTEO ANO CONTRIBUTE THAT
C----- AMOUNT TO THE FREE WATER
   40 FREWT = FREWT + POTMLT
C-----COMPUTE THE NEW HOLOING CAPACITY OF THE PACK ANO COMPARE IT WITH
C----- THE FREE WATER TO SEE IF SNOWMELT IS PROOUCEO
      HOLDCP = 0.04 * (PREWE - FREWT)
      COMPAR = FREWT - HOLOCP
      IF(COMPAR.LE.0.0) RETURN
C-----THE SNOWMELT CONTRIBUTEO IS IN -COMPAR-.  REOUCE THE FREE WATER
C----- TO LEAVE A PRIMEO PACK ANO REOUCE THE PREOICTEO WATER EQUIVALENT
      PREWE = PREWE - COMPAR
      WATRIN = WATRIN + COMPAR
      FREWT = HOLOCP
      RETURN
      END
```

Subroutine CALOSS

```
      SUBROUTINE CALOSS (CALOUT)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF THE CALORIC LOSS ON THE
C----- SNOWPACK
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVON,OREOY,ENGBL,
     1 ENGBLO,FIELOC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER OREOY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RAOLWN,RAOSWN,TMPMAX,TMPMIN,WATRIN
C-----AOO ALGEBRAICALLY THESE CALORIES INTO THE ENERGY BALANCE
      ENGBL = ENGBL + CALOUT
C-----SEE IF THERE IS ANY FREE WATER IN THE PACK.  IF NOT, THE LOSS IS
C----- JUST CONTRIBUTEO TO THE CALORIC OEFICIT OF THE SNOWPACK.
C----- REMEMBER THAT -CALOUT- IS NEGATIVE
      IF(FREWT.GT.0.0) GO TO 10
      CALOF = CALOF - CALOUT
      RETURN
C-----COMPUTE THE CALORIC LOSS NECESSARY TO FREEZE ALL OF THE FREE WATER
C----- (FREE WATER * 80.0 * 2.54)
   10 CALNED = FREWT * 203.2
C-----NOW COMPARE THAT NECESSARY LOSS WITH THE ACTUAL LOSS.  IF THEY ARE
C----- THE SAME, THE FREE WATER IS WIPEO OUT BUT NO OTHER CONOITIONS ARE
C----- ALTEREO
      COMPAR = CALOUT + CALNEO
      IF(COMPAR) 20,30,40
C-----THE LOSS WAS MORE THAN ENOUGH TO FREEZE IT.  THE BALANCE CREATES
C----- AN ENERGY OEFICIT IN THE PACK ANO THE FREE WATER IS WIPEO OUT
   20 CALOF = - COMPAR
   30 FREWT = 0.0
      RETURN
C-----ONLY PART OF THE FREE WATER FROZE.  COMPUTE THE BALANCE REMAINING
C----- BALANCE = EXISTING FREE WATER - AMOUNT FROZEN, WHERE
C----- AMOUNT FROZEN = CALORIES/(80.0 * 2.54)
   40 FREWT = FREWT + (CALOUT/203.2)
      RETURN
      END
```

Subroutine CANVAP

```
      SUBROUTINE CANVAP
C-----COMPUTE THE EVAPORATION FROM THE INTERCEPTED SNOW AS A FUNCTION OF
C----- THE CANOPY COVER OENSITY.  NOTE - THIS VERSION REPLACEO THE
C----- ORIGINAL SUBROUTINE CANVAP IN OECEMBER, 1973, TO INCORPORATE THE
C----- TIME TRENDS OF REGROWTH
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVON,OREOY,ENGBL,
     1 ENGBLO,FIELOC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER OREOY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RAOLWN,RAOSWN,TMPMAX,TMPMIN,WATRIN
      COMMON/TIME/CANREF,COMAX2,CONAV
C-----IF THE COVER OENSITY IS GREATER THAN OR EOUAL TO HALF OF THE
C----- MAXIMUM COVER OENSITY (ASSUMES COMPLETE OR NEARLY COMPLETE
C----- CROWN COVER AT COMAX/2), EVAPORATE ONLY FROM THE CANOPY
      IF(COMAX2 - COVON) 10,10,40
   10 ETFROM = 1.0
      EVAPTR = EVAPTR/COVON
      ONTRE = ONTRE - EVAPTR
      IF(ONTRE) 20,30,30
   20 EVAPTR = ONTRE + EVAPTR
      ONTRE = 0.0
   30 RETURN
C-----EVAPORATE FROM THE SNOWPACK SURFACE (USING THE PROCEOURES OF
C----- SUBROUTINE SNOVAP) ANO FROM THE CANOPY, COMBINING THE RESULTS AS
C----- A FUNCTION OF THE PRESENT PERCENTAGE OF CROWN COVER
   40 ETFROM = 3.0
      PRCNTC = COVON/COMAX2
      ETS = ((1.0 - COVON) * EVAPTR) * (1.0 - PRCNTC)
      IF(PREWE - ETS) 50,50,60
   50 ETS = PREWE
      PREWE = 0.0
      GO TO 70
   60 PREWE = PREWE - ETS
   70 ETC = (EVAPTR/COVON) * PRCNTC
      ONTRE = ONTRE - ETC
      IF(ONTRE) 80,90,90
   80 ETC = ONTRE + ETC
      ONTRE = 0.0
   90 EVAPTR = ETC + ETS
      RETURN
      END
```

Subroutine DECID

```
      SUBROUTINE OECIO
C-----OECIOUOUS FOREST - OETERMINE THE SOURCE OF THE EVAPOTRANSPIRATION
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVON,OREOY,ENGBL,
     1 ENGBLO,FIELOC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER OREOY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RAOLWN,RAOSWN,TMPMAX,TMPMIN,WATRIN
C-----IF FOLIAGE IS PRESENT, USE EVAPOTRANSPIRATION
      IF(VEGTYP - 3) 40,10
C-----IF THERE IS NO PACK, BYPASS THE RAOIATION ROUTINES
   10 IF(PREWE) 20,30
   20 CALL RADBAL
C-----AOO -WATRIN- TO THE RECHARGE REQUIREMENTS SO THE ET ROUTINE CAN
C----- OPERATE ON THE INPUT AS WELL AS THE STORAGE
   30 RCHRG = RCHRG + WATRIN
C-----0.14925 = 0.10/0.67 (SEE THE COMMENT IN SUBROUTINE EVTRAN FOR THE
C----- USE OF THE CONSTANT)
      CALL EVTRAN (0.14925)
      RETURN
C-----SINCE FOLIAGE IS NOT PRESENT, EVAPORATE FROM THE PACK SURFACE IF A
C----- PACK EXISTS
   40 IF(PREWE) 50,60
   50 CALL SNOVAP
      CALL RADBAL
C-----AOO -WATRIN- TO THE RECHARGE REQUIREMENTS
      RCHRG = RCHRG + WATRIN
      RETURN
C-----NEITHER FOLIAGE NOR PACK ARE PRESENT.  AOJUST THE EVAPORATION FOR
C----- AVAILABLE SOIL WATER BY THE SAME RELATIONSHIP USED IN EVTRAN FOR
C----- OPENINGS, THEN AOJUST FOR COVER OENSITY AS IN SNOWVAP (USE ANY
C----- INPUT TO HELP SATISFY THE REQUIREMENTS)
   60 ETFROM = 4.0
      RCHRG = RCHRG + WATRIN
      IF(RCHRG + (FIELOC/4.0)) 70,70,80
   70 EVAPTR = 0.0
      RETURN
   80 AVABLE = ((4.0/FIELOC) * (FIELOC + RCHRG)) - 3.0
      EVAPTR = EVAPTR * AVABLE * (1.0 - COVON)
      IF(RCHRG - EVAPTR + FIELOC) 90,100,100
   90 EVAPTR = RCHRG + FIELOC
      RCHRG = - FIELOC
      RETURN
  100 RCHRG = RCHRG - EVAPTR
      RETURN
      END
```

Subroutine DIFMOD

```
      SUBROUTINE OIFMOO
C-----THIS SUBROUTINE WAS OERIVEO FROM PROGRAM SMTM, A SNOWPACK
C----- TEMPERATURE OIFFUSION MOOEL OEVELOPEO BY LEAF (1970 STUOY PLAN
C----- FS-RM-1602, NO. 224, RMF+RES).  USING THE AVERAGE SURFACE TEMP
C----- AND THE GROUNO TEMP AS BOUNOARY CONOITIONS, THE NEW AVERAGE
C----- SNOWPACK TEMPERATURE IS CALCULATEO
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVON,OREOY,ENGBL,
     1 ENGBLO,FIELOC,FREWT,LSUSD,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER OREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKEO,PRECIP,RAOIN,
     1 RADLWN,RAOSWN,TMPMAX,TMPMIN,WATRIN
C-----COMPUTE THE OENSITY OF THE SNOWPACK (THE FUNCTION WAS OERIVEO FROM
C----- OBSERVEO CONOITIONS ON THE FRASER EXPERIMENTAL FOREST)
      OENSTY = (EXP((0.0179 * PREWE) + 3.02))/100.0
C-----COMPUTE THE OISTANCE BETWEEN THE TWO NOOES IN CENTIMETERS
C-----OEPTH = PREWE/OENSTY
C-----H = (OEPTH/2)*2.54
      H = (PREWE/DENSTY) * 1.27
C-----THE THERMAL OIFFUSIVITY IS CALCULATEO FROM THE FUNCTION
C----- KV = 0.01/((2.751 - OENSTY)* 0.48).  MATHEMATICAL STABILITY
C----- REQUIRES THAT THE VALUE OF THE QUANTITY (INTERVAL IN SECONOS *
C----- KV/H**2) BE LESS THAN 0.5.  WHEN A 24 HOUR INTERVAL IS USED, THE
C----- SNOW OEPTH MUST EXCEEO 30 INCHES (20 PERCENT DENSITY) TO ACHIEVE
C----- STABILITY.  IN ORDER TO INSURE STABILITY WITH SOMEWHAT SHALLOWER
C----- PACKS (ABOUT 18 INCHES), THE OAY IS OIVIOEO INTO 2 TIME INTERVALS
C----- OF 12 HOURS (43200 SECONOS)
C-----CONST1 = (43200 * 0.01/((2.751 - OENSTY) * 0.48))/H**2
      CONST1 = 900.0/((2.751 - DENSTY)*H*H)
C-----THE MINIMUM WATER EQUIVALENT WHICH WILL ACHIEVE STABILITY USING
C----- THE ABOVE OENSITY FUNCTION IS 4.7 INCHES
      IF(CONST1 - 0.5) 20,10,10
```

```
C-----THE MODEL IS UNSTABLE - INDICATE THAT IT IS NOT READY FOR USE NOW.
C----- (IT MAY BE INITIALIZED AGAIN BY AN OBSERVED PACK TEMPERATURE CARD
C----- AND STABILITY WILL BE ASCERTAINED FROM THE WATER EQUIVALENT AT
C----- THAT TIME)
   10 DREDY = 0
      RETURN
C-----GET THE SECOND CONSTANT
   20 CONST2 = 1.0 - CONST1 - CONST1
C-----PERFORM THE SIMULATION IN TWO PARTS (ONE FOR EACH 12 HOUR PERIOD).
C----- -SMTM1- HOLDS THE THREE TEMPERATURES FROM THE PREVIOUS INTERVAL
C----- THAT ARE NEEDED TO SIMULATE SMTM2, THE NODE AT THE CENTER OF
C----- THE PACK.  SIMULATE THE FIRST 12 HOURS NOW
      SMTM2 = (CONST1 * (SMTM1(1) + SMTM1(3))) + (CONST2 * SMTM1
     1(2))
C-----THE AVERAGE SNOWPACK TEMPERATURE IS THE AVERAGE OF THE 2 NODES
C----- (MIDDLE AND GROUND) IN BOTH INTERVALS.  GROUND TEMPERATURE IS
C----- CONSTANT, SO START THE AVERAGE NOW
      SMTM3 = SMTM1(3) + SMTM1(3) + SMTM2
C-----RESET -SMTM1- TO THE TEMPERATURES OF THE INTERVAL JUST SIMULATED
C----- FOR USE IN THE SECOND 12 HOUR INTERVAL SIMULATION.  THE SURFACE
C----- AIR TEMPERATURE IS SPLIT INTO A LOW AVERAGE ( (MEAN+MIN)/2 ) AND
C----- A HIGH AVERAGE ( (MEAN+MAX)/2 ) FOR USE WITH THE TWELVE HOUR
C----- INTERVALS.  USE THE LOW AVERAGE NOW
      SMTM1(1) = AMIN1 (0.0,(((TMPMIN-32.0)*0.5555555556)+AVETMC)/
     1 2.0)
      SMTM1(2) = SMTM2
C-----SIMULATE THE SECOND 12 HOURS AND COMPUTE THE AVERAGE SNOWPACK
C----- TEMPERATURE
      SMTM2 = (CONST1 * (SMTM1(1) + SMTM1(3))) + (CONST2 * SMTM1
     1(2))
      SMTM3 = (SMTM3 + SMTM2)/4.0
C-----RESET -SMTM1- USING THE HIGH AVERAGE FOR USE ON THE FIRST
C----- INTERVAL OF THE NEXT DAY
      SMTM1(1) = AMIN1 (0.0,(((TMPMAX-32.0)*0.5555555556)+AVETMC)/
     1 2.0)
      SMTM1(2) = SMTM2
C-----CHECK TO SEE IF THE GROUND TEMPERATURE SHOULD BE RAISED
      IF(SMTM3 + 1.5) 60,40,30
   30 IF(SMTM3 + 0.5) 40,50,50
   40 IF(SMTM1(3).LT.-0.5) SMTM1(3) = -0.5
      RETURN
   50 SMTM1(3) = 0.0
   60 RETURN
      END
```

Subroutine EVTRAN

```
      SUBROUTINE EVTRAN
C-----COMPUTE THE EVAPORATION AND TRANSPIRATION DURING THE GROWING
C----- SEASON.  NOTE - THIS VERSION REPLACED THE ORIGINAL SUBROUTINE
C----- EVTRAN IN DECEMBER, 1973, TO INCORPORATE THE TIME TRENDS OF
C----- REGROWTH
      COMMON/ONLYCR/ AVETMC,BASTMF,CALDF,CDMAX,CDVON,DREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSD,NOSND,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER DREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRD,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      COMMON/TIME/CANREF,CDMAX2,CONAV
      ETFROM = 4.0
C-----GET THE ADJUSTMENT FACTOR FOR AVAILABLE SOIL WATER
C-----AVABLE = 4*EXP(-K*(T-TC))*(BETA/M - EXP(-K*(T-TC)) + 1.0, WHEN
C----- T (YEARS SINCE TREATMENT) IS GREATER THAN OR EQUAL TO TC (BASE
C----- YEAR OF FUNCTION).  THE CONSTANT K IS CALCULATED WHEN THE
C----- MANAGEMENT PLAN CARD IS READ, AND THE CONSTANT -CONAV- IS
C----- COMPUTED AT THE BEGINNING OF EACH WATER YEAR BY THE TIME TRENDS
C----- ROUTINE.  BETA IS THE AVAILABLE WATER
      AVABLE = (4.0*CONAV*(((RCHRG+FIELDC)/FIELDC)-CONAV)) + 1.0
      IF(AVABLE) 10,10,20
C-----THE WILTING POINT HAS BEEN REACHED
   10 EVAPTR = 0.0
      RETURN
   20 IF(1.0 - AVABLE) 30,40,40
C-----THE FACTOR IS MAXIMIZED
   30 AVABLE = 1.0
C-----THE ADJUSTMENT FOR CANOPY REFLECTIVITY IS RECOMPUTED EACH YEAR.
C----- PERFORM THE ADJUSTMENTS NOW
   40 EVAPTR = EVAPTR * AVABLE * CANREF
C-----IF THE EVAPOTRANSPIRATION WILL DEPLETE THE MANTLE STORAGE BELOW
C----- THE WILTING POINT, ALTER THE EVAPOTRANSPIRATION
      IF(RCHRG - EVAPTR + FIELDC) 50,60,60
   50 EVAPTR = RCHRG + FIELDC
      RCHRG = - FIELDC
      RETURN
   60 RCHRG = RCHRG - EVAPTR
      RETURN
      END
```

Subroutine LINK

```
      SUBROUTINE LINK (CALAIR,CALRIE,IRETRN)
C-----THIS SUBROUTINE IS THE INTERFACE BETWEEN THE RADIATION BALANCE
C----- (SUBROUTINE RADBAL) AND THE DIFFUSION MODEL (SUBROUTINE DIFMOD)
      COMMON/ONLYCR/ AVETMC,BASTMF,CALDF,CDMAX,CDVON,DREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSD,NOSND,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER DREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRD,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
C-----SEE IF THE RADIATION BALANCE IS AN ENERGY LOSS OR GAIN
      IF(CALRIE) 10,10,80
C-----THERE WAS A LOSS.  IF THIS IS STILL WINTER (NO FREE WATER), JUST
C----- GO AHEAD AND USE THE DIFFUSION MODEL
   10 IF(FREWT) 20,20,50
C-----USE THE DIFFUSION MODEL TO SIMULATE THE CURRENT AVERAGE SNOWPACK
C-----TEMPERATURE
   20 IF(DREDY.NE.1) GO TO 140
      CALL DIFMOD
      IF(DREDY) 40,40,30
C-----NOW MAKE ANY NECESSARY ADJUSTMENTS IN THE RADIATION BALANCE TO
C----- CAUSE THE PACK TEMPERATURE TO BE THE SAME AS -SMTM3-. GET THE
C----- DIFFERENCE BETWEEN THE CALORIE DEFICITS AS COMPUTED BY THE
C----- DIFFERENT METHODS
   30 CALOM = CALDF + (SMTM3 * PREWE * 1.27)
C-----ADJUST THE LONG WAVE PORTION OF THE RADIATION BALANCE BY THE
C----- DIFFERENCE BETWEEN THE CALORIES DERIVED FROM THE DIFFUSION MODEL
C----- AND THE ENERGY BALANCE
      CALRIE = CALOM
      RADLWN = CALRIE - RADSWN
   40 IRETRN = 0
      RETURN
C-----THE LOSS IS USED TO FREEZE PART OR ALL OF THE FREE WATER, BUT IT
C----- MAY NOT CREATE COLD CONTENT.  IF IT WOULD CREATE COLD CONTENT,
C----- RE-INITIALIZE THE DIFFUSION MODEL TO 0 AND ADJUST THE ENERGY
C----- BALANCE ACCORDINGLY
   50 CALL CALOSS (CALRIE)
      IF(FREWT - 0.05) 60,60,70
   60 SMTM1(1) = AMIN1 (AVETMC,0.0)
      SMTM1(2) = 0.0
      SMTM1(3) = 0.0
      DREDY = 1
C-----MAKE ANY NECESSARY ADJUSTMENTS TO THE ENERGY BALANCE TO COMPENSATE
C----- FOR THE COLD CONTENT THAT WOULD HAVE BEEN GENERATED BY THIS LOSS
C----- AND ZERO THE COLD CONTENT
      ENGBL = ENGBL + CALDF
      RADLWN = RADLWN + CALDF
      FREWT = 0.0
      CALDF = 0.0
   70 IRETRN = 1
      RETURN
C-----THERE IS CALORIC INPUT TO THE PACK.  CHECK TO SEE IF CONDITIONS
C----- INDICATE THAT THE DIFFUSION MODEL SHOULD BE TURNED OFF AND THE
C----- ENERGY BALANCE USED FOR SPRINGTIME SIMULATION.  CONSIDER FIRST
C----- ANY COLD CONTENT (INCLUDING THAT OF THE PREVIOUS DAY AND ANY
C----- CREATED BY A SNOW EVENT ON THIS DAY).  IF THERE IS COLD CONTENT,
C----- CHECK THE AVERAGE AIR TEMPERATURE AND THE SNOWPACK TEMPERATURE
C----- FROM THE PREVIOUS DAY FOR ARBITRARILY CHOSEN SPRINGTIME
C----- CONDITIONS AND IF ALL ARE NOT SATISFIED, GO AHEAD AND USE THE
C----- DIFFUSION MODEL
   80 IF(CALDF) 170,170,90
C-----0.889 = 1.27 * 0.7 DEGREES C (ARBITRARY TEMP)
   90 IF(AVETMC.LE.0.0.OR.CALDF.GT.PREWE*0.889) GO TO 20
C-----SINCE SPRINGTIME CONDITIONS PREVAIL, RECOMPUTE THE BACK RADIATION
C----- AND THE NET RADIATION BALANCE (REMEMBER, IF THERE IS SNOW, THE
C----- LONGWAVE IS ASSUMED TO BE ZERO, SO THERE WOULD BE NO NEED TO MAKE
C----- ANY ADJUSTMENTS)
      IF(NOSND) 140,140,100
  100 USE = (TMPMIN - 32.0) * 0.5555555556
      IF(USE.GT.0.0) USE = 0.0
      CALSND = 1.17E-7 * ((USE + 273.16) ** 4)
      IF(PRECIP) 110,110,120
  110 RADLWN = ((1.0 - CDVON) * ((0.757 * CALAIR) - CALSND)) + (CDVON
     1 * (CALAIR - CALSND))
      GO TO 130
  120 RADLWN = CALAIR - CALSND
  130 CALRIE = RADSWN + RADLWN
C-----RE-INITIALIZE THE DIFFUSION MODEL TO THESE CONDITIONS (BUT IF THE
C----- INPUT IS MORE THAN ENOUGH TO WIPE OUT THE CALORIE DEFICIT, JUST
C----- LET IT BRING THE PACK TO ISOTHERMAL.  IN THIS WAY, TWO CONSECU-
C----- TIVE DAYS OF INPUT ARE REQUIRED TO GENERATE FREE WATER)
  140 COMPAR = CALRIE - CALDF
      IF(COMPAR) 160,150,150
C-----INITIALIZE THE DIFFUSION MODEL TO ISOTHERMAL CONDITIONS
  150 SMTM1(1) = 0.0
      SMTM1(2) = 0.0
      SMTM1(3) = 0.0
      SMTM3 = 0.0
      DREDY = 1
      GO TO 30
C-----REDEFINE THE SURFACE TEMPERATURE AND COMPUTE THE NEW AVERAGE PACK
C----- TEMPERATURE.  THEN COMPUTE THE MIDDLE NODE AS A FUNCTION OF THAT
C----- AVERAGE, THE SURFACE TEMPERATURE AND THE GROUND TEMPERATURE
C----- (WHICH REMAINED UNCHANGED)
  160 SMTM1(1) = AMIN1 (0.0,AVETMC)
      SMTM3 = COMPAR/(PREWE * 1.27)
      SMTM1(2) = (3.0 * SMTM3) - SMTM1(1) - SMTM1(3)
      SMTM1(3) = 0.0
      DREDY = 1
      GO TO 30
C-----THERE IS INPUT TO THE PACK AND THE PACK IS ALREADY ISOTHERMAL.  IF
C----- THIS ENERGY WILL CREATE AT LEAST 0.05 INCH (ARBITRARY AMOUNT) OF
C----- FREE WATER, SET THE DIFFUSION MODEL TO STANDBY STATUS AND LET THE
C----- ENERGY BALANCE TAKE ITS COURSE
  170 IF(FREWT + (CALRIE/203.2) - 0.05) 150,180,180
  180 DREDY = 0
      IRETRN = 0
      RETURN
      END
```

Subroutine MIXTUR

```
      SUBROUTINE MIXTUR
C----THIS SUBROUTINE CONTROLS THE COMPUTATIONS FOR A PRECIPITATION
C----- EVENT THAT IS A MIXTURE OF SNOW AND RAIN
      COMMON/ONLYCP/ AVETMC,BASTMF,CALDF,CDMAX,CDVON,DREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSD,NOSND,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER DREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRD,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
C-----COMPUTE THE AMOUNT OF PRECIPITATION OCCURRING AS RAIN
C----- AMOUNT RAIN = P * (B/A), WHERE
C----- P = PRECIPITATION IN INCHES
C----- B = DAILY MAXIMUM TEMPERATURE - BASE TEMPERATURE (DEGREES F)
C----- A = DAILY MAXIMUM TEMPERATURE - MINIMUM TEMPERATURE (DEGREES F)
      B = TMPMAX - BASTMF
      A = TMPMAX - TMPMIN
      AMTRAN = PRECIP * (B/A)
C-----NOW COMPUTE THE AVERAGE TEMPERATURES (DEGREES C) WHICH PRODUCE
C----- SNOW AND RAIN
      TMSND = (TMPMIN + BASTMF - 64.0) * 0.2777777778
      TMRAIN = (TMPMAX + BASTMF - 64.0) * 0.2777777778
C-----COMPUTE THE EFFECT OF THE SNOW ON THE SNOWPACK
```

```
      CALL SNOWED (TMSNO,PRECIP-AMTRAN)
C-----COMPUTE THE EFFECT OF THAT PORTION OF THE PRECIPITATION OCCURRING
C----- AS RAIN ON THE SNOWPACK
      CALL RAINED (TMAIN,AMTRAN)
      RETURN
      END
```

Function PACKRF

```
      FUNCTION PACKRF (DUMMY)
C-----GET THE REFLECTIVITY OF THE SNOWPACK
      COMMON/ONLYCR/ AVETMC,BASTMF,CALDF,COMAX,COVON,OREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER OREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      DIMENSION REFACM(15),REFMLT(15)
      INTEGER PASINT
      DATA REFACM/.80, .77, .75, .72, .70, .69, .68, .67, .66, .65,
     1 .64, .63, .62, .61, .60/
      DATA REFMLT/.72, .65, .60, .58, .56, .54, .52, .50, .48, .46,
     1 .44, .43, .42, .41, .40/
      PASINT = NOSNO
      IF(NOSNO) 80,80,10
C-----USE THE SAME FUNCTION AS LAST TIME
   10 IF(LSUSO) 20,20,50
C-----ACCUMULATION PHASE - AFTER 15 DAYS, USE THE MELT FUNCTION
C----- STARTING AT THE FOURTH DAY
   20 IF(PASINT - 15) 30,30,40
   30 PACKRF = REFACM(PASINT)
      RETURN
   40 PASINT = PASINT - 11
C-----MELT FUNCTION - AFTER 15 DAYS, USE A CONSTANT 40 PERCENT
   50 IF(PASINT - 15) 70,70,60
   60 PASINT = 15
   70 PACKRF = REFMLT(PASINT)
      RETURN
C-----THERE IS NEW SNOW - DETERMINE IF THE FUNCTION IS TO BE RE-
C----- INITIALIZED
   80 IF(TMPMAX - TRSHLD) 90,90,10
C-----IT IS, SO SEE WHICH FUNCTION IS TO BE USED
   90 IF(CALDF) 110,110,100
  100 PACKRF = 0.91
      LSUSO = 0
      RETURN
C-----THE PACK IS ISOTHERMAL, BUT IF THE ENERGY BALANCE FROM THE
C----- PREVIOUS INTERVAL WAS NEGATIVE, USE THE ACCUMULATION PHASE
C----- FUNCTION ANYWAY
  110 IF(ENGBLO) 100,120,120
  120 PACKRF = 0.81
      LSUSO = 1
      RETURN
      END
```

Subroutine RADBAL

```
      SUBROUTINE RADBAL
C-----THIS SUBROUTINE COMPUTES THE RADIATION BALANCE AND TRANSFERS
C----- CONTROL TO THE DIFFUSION MODEL THROUGH SUBROUTINE LINK IF IT IS
C----- NEEDED
      COMMON/ONLYCR/ AVETMC,BASTMF,CALDF,COMAX,COVON,OREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER OREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
C-----COMPUTE THE CALORIC INPUT FROM NET SHORT WAVE RADIATION AS A
C----- FUNCTION OF THE SNOWPACK REFLECTIVITY
      RADSWN = RADIN * (1.0 - PACKRF (0.0)) * TCOEF
C-----IF THE PACK IS ACCUMULATING, BUT IS NOT DEEP ENOUGH FOR STABILITY
C----- IN THE DIFFUSION MODEL, USE THE FOLLOWING SIMPLIFIED METHOD FOR
C----- DERIVING THE RADIATION BALANCE
      IF(PHASE) 70,10,110
   10 IF(PREWE - 4.7) 20,50,50
C-----USE ONLY THE SHORTWAVE INPUT (THIS IMPLIES THAT THE ONLY COLD
C----- CONTENT GENERATED IN THE ACCUMULATING PACK IS THAT OF NEW SNOW)
   20 CALRIE = RADSWN
      RADLWN = 0.0
      CALL CALIN (CALRIE)
C-----MELT CAN OCCUR ONLY WHEN THE MEAN TEMPERATURE IS GREATER THAN THE
C----- SPECIFIED MINIMUM
      IF(AVETMC - TMPMLT) 30,30,40
   30 PREWE = PREWE + WATRIN
      RADLWN = -ENGBL
      ENGBL = 0.0
      WATRIN = 0.0
      FREWT = 0.0
      CALDF = 0.0
   40 RETURN
C-----THE PACK HAS JUST REACHED A SUFFICIENT DEPTH.  INITIALIZE THE
C----- DIFFUSION MODEL, BUT RETAIN PSEUDO-CONTROL UNTIL THE DIFFUSION
C----- MODEL IS WELL ALONG INTO STABLE CONTROL
   50 PHASE = -1
   60 OREDY = 1
      PREWE = PREWE + WATRIN
      WATRIN = 0.0
      RADLWN = - RADSWN
      CALDF = 0.0
      ENGBL = 0.0
      SMTM1(1) = AMIN1 (AVETMC,0.0)
      SMTM1(2) = 0.0
      SMTM1(3) = 0.0
      FREWT = 0.0
      RETURN
C-----THE DIFFUSION MODEL HAS BEEN INITIALIZED PREVIOUSLY.  IF IT IS
C----- STILL STABLE AND IF THE PACK IS DEEP ENOUGH TO INSURE CONTINUED
C----- STABILITY UNTIL MELT, RELINQUISH CONTROL COMPLETELY TO THE
C----- NORMAL METHOD OF COMPUTING THE RADIATION BALANCE, INTERFACED WITH
C----- THE DIFFUSION MODEL
   70 IF(OREDY) 170,80,90
   80 PHASE = 0
      GO TO 10
   90 CALRIE = RADSWN
      CALAIR = 0.0
      RADLWN = 0.0
      IF(PREWE - 5.0) 230,230,100
  100 PHASE = 1
C-----USE THE NORMAL METHOD OF COMPUTING THE RADIATION BALANCE.  IF ANY
C----- OF THE PRECIP WAS SNOW, THE NET LONG WAVE RADIATION BALANCE IS
C----- ASSUMED TO BE ZERO
      GO TO 170
C-----SEE IF THIS IS THE ACCUMULATION PHASE OR MELT PHASE
  110 IF(PHASE - 2) 120,170
C-----ACCUMULATING - IF THE DIFFUSION MODEL IS STILL READY, GO ON TO THE
C----- NORMAL ROUTINE.  BUT IF NOT, JUST USE THE SIMPLE ONE
  120 IF(OREDY) 170,130,150
  130 CALRIE = RADSWN
      RADLWN = 0.0
      CALL CALIN (CALRIE)
      IF(AVETMC - TMPMLT) 140,40,40
  140 IF(PREWE - 4.7) 30,60,60
C-----SEE IF THE PEAK WATER EQUIVALENT DATE HAS BEEN REACHED
  150 IF(PEAKED) 160,170
  160 PHASE = 2
  170 IF(NOSNO) 180,180,190
  180 RADLWN = 0.0
      CALAIR = 0.0
      GO TO 220
C-----TO COMPUTE THE LONG WAVE RADIATION COMPONENTS, CONVERT THE AIR
C----- AND SNOW TEMPERATURES TO POTENTIAL CALORIES BY THE STEFAN -
C----- BLOTZMANN FUNCTION, CALORIES = S * (T ** 4), WHERE
C----- S = 1.17E-7 CAL/((CM**2)(DEGREES KELVIN)**4), AND
C----- T = ABSOLUTE TEMPERATURE (DEGREES KELVIN)
  190 CALAIR = 1.17E-7 * ((AVETMC + 273.16) ** 4)
      USE = AVETMC
C-----IF THE SNOWPACK IS ISOTHERMAL, USE THE MINIMUM TEMPERATURE FOR
C----- COMPUTING THE BACK RADIATION
      IF(CALDF.EQ.0.0) USE = (TMPMIN - 32.0) * 0.5555555556
C-----UNDER NO CIRCUMSTANCES MAY THE TEMPERATURE FOR COMPUTING THE BACK
C----- RADIATION BE GREATER THAN ZERO
      IF(USE.GT.0.0) USE = 0.0
      CALSNO = 1.17E-7 * ((USE + 273.16) ** 4)
C-----COMPUTE THE LONG WAVE RADIATION COMPONENTS AS A FUNCTION OF THE
C----- FIRST, DETERMINE WHETHER THE SKIES ARE CLEAR OR CLOUDY
      IF(PRECIP) 200,200,210
C-----WITH CLEAR SKIES, THE DOWNWARD LONGWAVE RADIATION COEFFICIENT IS
C----- .757 (RUNOFF FROM SNOWMELT, EM1110-2-1406, US ARMY CORPS OF
C----- ENGINEERS, 1960, PAGE 7)
  200 SNOSKY = (1.0 - COVON) * ((0.757 * CALAIR) - CALSNO)
C-----THE DOWNWARD LONGWAVE RADIATION COEFFICIENT IS 1.0 BENEATH THE
C----- FOREST CANOPY (OR BENEATH CLOUDY SKIES)
      SNOCAN = COVON * (CALAIR - CALSNO)
      RADLWN = SNOCAN + SNOSKY
      GO TO 220
C-----WITH CLOUDY SKIES, WHEN THE DOWNWARD LONGWAVE RADIATION COEFFI-
C----- CIENT IS 1.0 INSTEAD OF .757, THE ABOVE THREE EQUATIONS MAY BE
C----- REDUCED ALGEBRAICALLY TO THE FOLLOWING SINGLE EQUATION
  210 RADLWN = CALAIR - CALSNO
C-----COMPUTE THE CALORIC INPUT OR LOSS FROM THE NET EFFECT OF SHORT
C----- WAVE AND LONG WAVE RADIATION
  220 CALRIE = RADSWN + RADLWN
C-----THE SNOWPACK TEMPERATURE DIFFUSION MODEL (LEAF, 1970, STUDY PLAN
C----- FS-RM-1602, NO. 224.  ROCKY MOUNTAIN FOREST AND RANGE EXP STA) IS
C----- INCORPORATED TO CONTROL THE SNOWPACK TEMPERATURE AND COLD CONTENT
C----- DURING NON-ISOTHERMAL CONDITIONS.  SEE NOW IF THE DIFFUSION MODEL
C----- MAY BE USED (OREDY MAY NOT BE -1 AND PASS THROUGH LINK SINCE IT
C----- IS NOT DESIGNED TO WORK WITH IT.  THE -1 IS USED TO INDICATE THAT
C----- THE RADIATION ROUTINES ARE TO BE USED EXCLUSIVELY).  IF IT MAY BE
C----- USED, PASS THROUGH THE LINKING ROUTINE WHICH INTERFACES THE
C----- DIFFUSION MODEL AND THE RADIATION ROUTINES
      IF(OREDY) 240,230,230
  230 CALL LINK (CALAIR,CALRIE,IRETRN)
      IF(IRETRN) 240,240,260
  240 IF(CALRIE) 250,260,270
  250 CALL CALOSS (CALRIE)
  260 RETURN
  270 CALL CALIN (CALRIE)
      RETURN
      END
```

Subroutine RAINED

```
      SUBROUTINE RAINED (TRAIN,AMTRAN)
C-----THIS SUBROUTINE COMPUTES THE EFFECT OF RAIN ON SNOW
      COMMON/ONLYCR/ AVETMC,BASTMF,CALDF,COMAX,COVON,OREDY,ENGBL,
     1 ENGBLO,FIELDC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLD,VEGTYP
      INTEGER OREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
C-----ADD THIS AMOUNT OF PRECIPITATION TO THE PREDICTED WATER EQUIVALENT
      PREWE = PREWE + AMTRAN
C-----SEE IF THERE IS A CALORIE DEFICIT IN THE PACK
      IF(CALDF) 50,50,10
C-----COMPUTE THE AMOUNT OF RAIN AT THIS TEMPERATURE THAT IS NEEDED TO
C----- WIPE OUT THE DEFICIT AND COMPARE IT WITH THE ACTUAL AMOUNT
   10 CALRAN = (80.0 + TRAIN) * 2.54
      AMTNED = CALDF/CALRAN
      COMPAR = AMTRAN - AMTNED
      IF(COMPAR) 30,20,40
C-----THERE WAS JUST ENOUGH TO WIPE OUT THE DEFICIT
   20 CALDF = 0.0
      ENGBL = ENGBL + CALRAN
      RETURN
C-----THERE WAS NOT ENOUGH TO WIPE IT OUT COMPLETELY.  JUST DEPLETE
C----- THE DEFICIT
   30 CALDF = CALDF - (CALRAN * AMTRAN)
      ENGBL = ENGBL + (CALRAN * AMTRAN)
      RETURN
C-----THERE WAS MORE THAN ENOUGH TO WIPE OUT THE DEFICIT.  THE AMOUNT
C----- OF RAIN NOT FROZEN IS FREE WATER
   40 FREWT = COMPAR
```

```
      CALL CALIN (TRAIN * COMPAR * 2.54)
      RETURN
C-----ALL OF THE RAIN IS ADDED TO THE FREE WATER AND CONTRIBUTES CALORIC
C----- INPUT TO THE PACK
   50 FREWT = FREWT + AMTRAN
      CALL CALIN (TRAIN * AMTRAN * 2.54)
      RETURN
      END
```

Subroutine SNOWED

```
      SUBROUTINE SNOWED (TSNOW,AMTSNO)
C-----THIS SUBROUTINE COMPUTES THE EFFECTS OF A SNOW EVENT ON THE
C----- SNOWPACK
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVDN,DREDY,ENGBL,
     1 ENGBLC,FIELDC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER DREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      REAL INTCPT
C-----SEE IF INTERCEPTION IS ALLOWED NOW
      IF(ALLOW) 10,30
C-----DETERMINE THE AMOUNT OF INTERCEPTED SNOW AS A FUNCTION OF COVER
C----- COMPOSITION AND COVER DENSITY (WATCH FOR OPENINGS AND DECIDUOUS
C----- FORESTS WITHOUT FOLIAGE)
   10 IF(COMAX) 20,30
   20 GO TO (40,50,40,30),VEGTYP
C-----NO INTERCEPTION
   30 INTCPT = 0.0
      GO TO 90
C-----LODGEPOLE PINE AND FOLIATED DECIDUOUS FORESTS
   40 PERCNT = 0.10
      GREAT = 0.20
      GO TO 60
C-----SPRUCE FIR
   50 PERCNT = 0.15
      GREAT = 0.30
   60 INTCPT = AMTSNO * PERCNT * (COVDN/COMAX)
      IF(ONTRE + INTCPT - GREAT) 80,80,70
   70 INTCPT = GREAT - ONTRE
   80 ONTRE = ONTRE + INTCPT
   90 NOSNO = 0
C-----ADD THIS AMOUNT OF PRECIPITATION TO THE PREDICTED WATER EQUIVALENT
      PREWE = PREWE + AMTSNO - INTCPT
C-----THE SNOW FALLING WHEN THE TEMPERATURE IS BETWEEN 35 AND 32 DEGREES
C----- DOES NOT ALTER THE CALORIC DEFICIT
      IF(TSNOW.GE.0.0) RETURN
C-----COMPUTE THE CALORIE DEFICIT FOR THIS SNOW BY THE EQUATION
C----- CALORIE DEFICIT = S(I)*DELTA T*P, WHERE
C----- S(I) = SPECIFIC HEAT OF ICE (.5 CAL/CM/DEGREES C),
C----- DELTA T = CHANGE IN TEMPERATURE WITH RESPECT TO FREEZING (0.0
C-----  DEGREES CENTIGRADE), AND
C----- P = PRECIPITATION IN CM (CONVERSION FACTOR = 2.54 CM/IN).
C----- THEREFORE, CALORIE DEFICIT = 0.5 * (TFORSNO) * (AMTSNO * 2.54)
      CALL CALOSS (TSNOW * (AMTSNO - INTCPT) * 1.27)
      RETURN
      END
```

Subroutine SNOVAP

```
      SUBROUTINE SNOVAP
C-----COMPUTE THE EVAPORATION FROM THE SURFACE OF THE SNOWPACK AS A
C----- FUNCTION OF THE COVER DENSITY AND REDUCE THE PACK ACCORDINGLY
      COMMON/ONLYCR/ AVETMC,BASTMF,CALOF,COMAX,COVDN,DREDY,ENGBL,
     1 ENGBLC,FIELDC,FREWT,LSUSO,NOSNO,ONTRE,PHASE,PREWE,
     2 RCHRG,SMTM1(3),SMTM3,TCOEF,TMPMLT,TRSHLO,VEGTYP
      INTEGER DREDY,PHASE,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      ETFROM = 2.0
      EVAPTR = (1.0 - COVDN) * EVAPTR
C-----SINCE DECIDUOUS FOREST AREAS MAY EVAPORATE FROM THE SNOWPACK WITH
C----- NO REGARD FOR PACK DEPTH, DO NOT ALLOW EVAPOTRANSPIRATION TO TAKE
C----- MORE THAN IS IN THE PACK
      IF(PREWE - EVAPTR) 10,10,20
   10 EVAPTR = PREWE
      PREWE = 0.0
      RETURN
   20 PREWE = PREWE - EVAPTR
      RETURN
      END
```

Subroutine DECDUS

```
      SUBROUTINE DECDUS
C-----CHECK FOR A CHANGE OF SEASON IN DECIDUOUS FORESTS
      COMMON/M/ALTYR(8),BOUND(6,8),CALOEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSO(8),LCOPY(14),NOYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEQ(8),RDIST(8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYP,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
C-----CHECK THE DATE (BETWEEN APRIL 1 AND OCTOBER 15, IT IS POSSIBLE TO
C----- HAVE FOLIAGE.  BUT DURING THE REMAINDER OF THE YEAR, IT IS
C----- ASSUMED THAT THE TREES ARE LEAFLESS)
      IF(NDAY.GE.187.OR.NDAY.LE.15) GO TO 30
C-----THE TREES SHOULD BE LEAFLESS.  (IF THEY ARE NOT, SWITCH TO THE
C----- LOWER COVER DENSITY
   10 IF(VEGTYP - 4) 20,80
   20 VEGTYP = 4
      GO TO 60
C-----THE FOLIAGE MAY BE PRESENT, BUT IF THE PACK WATER EQUIVALENT IS
C----- MORE THAN 5 INCHES, THE TREES ARE STILL ASSUMED TO BE LEAFLESS
   30 DO 40 I = 1,NUNIT
      IF(PREWEQ(I) - 5.0) 40,40,10
   40 CONTINUE
C-----THE FOLIAGE SHOULD BE PRESENT.  IF NOT, SWITCH TO THE HIGHER COVER
C----- DENSITY
      IF(VEGTYP - 3) 50,80
   50 VEGTYP = 3
   60 DO 70 I = 1,NUNIT
      TCOEFF(I) = SWITCH (TCOEFF(I),DECIDS(1,I))
      COVDEN(I) = SWITCH (COVDEN(I),DECIDS(2,I))
      COMAX = SWITCH (COMAX,DCOMAX)
   70 CONTINUE
   80 RETURN
      END
```

Subroutine GBIMON

```
      SUBROUTINE GBIMON
C-----GET THE BIMONTHLY RUNOFF
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
C-----APRIL 16 - APRIL 30
      BIMNTH(1) = 0.0
      DO 10 I = 202,216
   10 BIMNTH(1) = BIMNTH(1) + RO(I)
C-----MAY 1 - MAY 15
      BIMNTH(2) = 0.0
      DO 20 I = 218,232
   20 BIMNTH(2) = BIMNTH(2) + RO(I)
C-----MAY 16 - MAY 31
      BIMNTH(3) = 0.0
      DO 30 I = 233,248
   30 BIMNTH(3) = BIMNTH(3) + RO(I)
C-----JUNE 1 - JUNE 15
      BIMNTH(4) = 0.0
      DO 40 I = 249,263
   40 BIMNTH(4) = BIMNTH(4) + RO(I)
C-----JUNE 16 - JUNE 30
      BIMNTH(5) = 0.0
      DO 50 I = 264,278
   50 BIMNTH(5) = BIMNTH(5) + RO(I)
C-----JULY 1 - JULY 15
      BIMNTH(6) = 0.0
      DO 60 I = 280,294
   60 BIMNTH(6) = BIMNTH(6) + RO(I)
      RETURN
      END
```

Subroutine GPEAK

```
      SUBROUTINE GPEAK (IDATE1)
C-----GET THE PEAK 7-DAY FLOW AND PEAK WATER EQUIVALENT
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
C-----PEAK WATER EQUIVALENT
      PEAKWE = 0.0
      PEKDAT = 1
      DO 40 I = 1,372
      IF(TMAX(I) + 1.E50) 10,40
   10 IF(PEAKWE - WE(I)) 20,30,40
   20 PEAKWE = WE(I)
   30 PEKDAT = I
   40 CONTINUE
      CALL GDATE (PEKDAT,DATE)
C-----7-DAY PEAK FLOW
      IDATE1 = 1
      IDATE2 = 7
      PEAKRO = 0.0
      DO 110 I = 187,272
      IF(TMAX(I) + 1.E50) 50,110
   50 ACCUM = RO(I)
      J = 6
      K = I + 1
   60 IF(TMAX(K) + 1.E50) 70,80
   70 ACCUM = ACCUM + RO(K)
      J = J - 1
      IF(J) 80,90
   80 K = K + 1
      GO TO 60
   90 IF(PEAKRO - ACCUM) 100,110,110
  100 PEAKRO = ACCUM
      IDATE1 = I
      IDATE2 = K
```

```
  110 CONTINUE
C-----CONVERT THE DATES
      CALL GDATE (IDATE1,DATES(1))
      CALL GDATE (IDATE2,DATES(3))
      RETURN
      END
```

Function JWYDAT

```
      FUNCTION JWYDAT (MONTH,IDAY)
C-----CONVERT THE DATE TO A PSEUDO-JULIAN DATE SYSTEM, WHERE OCT 1 IS
C----- DAY 1.  CONSIDER ALL MONTHS AS HAVING 31 DAYS
C-----PSEUDO-JULIAN WATER YEAR DATE CONVERSION TABLE
C----- DAY  OCT  NOV  DEC  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP
C-----   1    1   32   63   94  125  156  187  218  249  280  311  342
C-----   2    2   33   64   95  126  157  188  219  250  281  312  343
C-----   3    3   34   65   96  127  158  189  220  251  282  313  344
C-----   4    4   35   66   97  128  159  190  221  252  283  314  345
C-----   5    5   36   67   98  129  160  191  222  253  284  315  346
C-----   6    6   37   68   99  130  161  192  223  254  285  316  347
C-----   7    7   38   69  100  131  162  193  224  255  286  317  348
C-----   8    8   39   70  101  132  163  194  225  256  287  318  349
C-----   9    9   40   71  102  133  164  195  226  257  288  319  350
C-----  10   10   41   72  103  134  165  196  227  258  289  320  351
C-----  11   11   42   73  104  135  166  197  228  259  290  321  352
C-----  12   12   43   74  105  136  167  198  229  260  291  322  353
C-----  13   13   44   75  106  137  168  199  230  261  292  323  354
C-----  13   13   44   75  106  137  168  199  230  261  292  323  354
C-----  14   14   45   76  107  138  169  200  231  262  293  324  355
C-----  15   15   46   77  108  139  170  201  232  263  294  325  356
C-----  16   16   47   78  109  140  171  202  233  264  295  326  357
C-----  17   17   48   79  110  141  172  203  234  265  296  327  358
C-----  18   18   49   80  111  142  173  204  235  266  297  328  359
C-----  19   19   50   81  112  143  174  205  236  267  298  329  360
C-----  20   20   51   82  113  144  175  206  237  268  299  330  361
C-----  21   21   52   83  114  145  176  207  238  269  300  331  362
C-----  22   22   53   84  115  146  177  208  239  270  301  332  363
C-----  23   23   54   85  116  147  178  209  240  271  302  333  364
C-----  24   24   55   86  117  148  179  210  241  272  303  334  365
C-----  25   25   56   87  118  149  180  211  242  273  304  335  366
C-----  26   26   57   88  119  150  181  212  243  274  305  336  367
C-----  27   27   58   89  120  151  182  213  244  275  306  337  368
C-----  28   28   59   90  121  152  183  214  245  276  307  338  369
C-----  29   29   60   91  122  153  184  215  246  277  308  339  370
C-----  30   30   61   92  123       185  216  247  278  309  340  371
C-----  31   31        93  124       186       248       310  341
      IF(MONTH - 10) 30,20,10
C-----NOVEMBER - DECEMBER
   10 JWYDAT = ((MONTH-10)*31) + IDAY
      GO TO 40
C-----OCTOBER
   20 JWYDAT = IDAY
      GO TO 40
C-----JANUARY - SEPTEMBER
   30 JWYDAT = ((MONTH+2)*31) + IDAY
   40 IF(JWYDAT.GT.0.AND.JWYDAT.LT.373) RETURN
      WRITE (6,910) MONTH,IDAY
  910 FORMAT(*0INVALID MONTH/DAY*15,*/*I2,* - JOB ABORTED*)
      CALL ABORT
      END
```

Subroutine OUTPT

```
      SUBROUTINE OUTPT
C-----OUTPUT THE COMPILED RESULTS AND WRITE THE BASIC DATA ON THE FILE
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 CDMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCDMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      INTEGER HEADER(2)
      DATA HEADER/8HNATURAL ,8HALTERED /
C-----CHECK THE LINE COUNTER
      IF(LINES) 10,10,20
   10 WRITE (6,910) REGION,DATIME,PLUNIT,HEADER(NRMANG)
  910 FORMAT(*1*8A10,32X2A10/1X6A10,54XA8,*CONDITIONS*/
     1 *GYEAR    - - - -BIMONTHLY GENERATED RUNOFF- - - -     - - - - - - -
     2YEARLY - - - - - - -      9/30    - - - - - - - - PEAK - - - - - - - -*/
     3 *          APRIL    MAY     MAY     JUNE    JUNE    JULY     GEN
     4       CHANGE CHANGE    RECH                       7-DAY*/
     5 *          16-30   1-15  16-31   1-15  16-30   1-15      RO      PPT
     6    CT    RECH    W.E.     REO    W.E.    DATE   GENRO       DATES*/)
      LINES = 50
C-----PRINT THE LINE
   20 WRITE (6,920) YEAR,BIMNTH,YRTOT,CHANGR,CHANGW,RCHRGO,PEAKWE,DATE,
     1 PEAKRO,DATES
  920 FORMAT(2XI3,1X13F7.2,2XI2,*/*I2,F7.2,2(2XI2,*/*I2))
      LINES = LINES - 1
      RETURN
      END
```

Function SWITCH

```
      FUNCTION SWITCH (VALNOW,STORED)
C-----SWITCH THE PRESENT VALUE AND ITS STORED COUNTERPART
      SWITCH = STORED
      STORED = VALNOW
      RETURN
      END
```

Function TC

```
      FUNCTION TC (CD)
C-----GENERATE THE TRANSMISSIVITY COEFFICIENT WHICH CORRESPONDS TO THE
C----- SPECIFIED COVER DENSITY
C-----THE .06 BELOW IS DEPENDENT ON THE FUNCTION VALUES AT STATEMENT 40
      IF(CD - .06) 10,10,20
   10 TC = 1.0
      RETURN
   20 IF(CD - 1.0) 40,30,30
   30 TC = 0.0
      RETURN
C-----THE FOLLOWING RELATIONSHIP REPRESENTS THE RESULTS OBTAINED DURING
C----- THE CALIBRATION OF THE WATER BALANCE MODEL WHEN THE COVER DENSITY
C----- AND TRANSMISSIVITY COEFFICIENT WERE ALLOWED TO VARY TO ESTABLISH
C----- REASONABLE MELT RATES ON EACH OF THE FRASER EXPERIMENTAL FOREST
C----- SUBSTATIONS IN 1969.  ONCE A COMBINATION HAD BEEN ESTABLISHED,
C----- IT WAS TESTED FOR 29 OTHER YEARS AND WAS FOUND TO BE SATISFACTORY
   40 TC = 0.18095/(CD ** 0.5786)
      RETURN
      END
```

Program NORMAL

```
      OVERLAY (OLAYS,2,1)
      PROGRAM NORMAL
C-----PERFORM THE NORMAL SIMULATION AND CREATE THE BASIC DATA FILE
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,COVDEN,DECIDS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTN,FREWAT,ID,IM,IMN,IMX,IP,IY,LASUSD,LAT,
     2 NDYSND,ONTRES,PEKPPT,PHASE,POTENT(24),POTRAD,PPTNOW,PREWEO,
     3 RADSUB,RECHRG,SIMTM1(3),SLOPE,SLPASP(24),SUMMER,TCDEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSUB,SLOPE,VARFMT
      COMMON/TIME/CANREF,CDMAX2,CONAV
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 CDMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCDMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      CALL CORE (-1)
      REWIND 16
C-----IF THIS IS FOR DATA BASE EXTENSION ONLY, BYPASS THE NORMAL PARTS
      IF(NRMANG.EQ.0) GO TO 100
C-----READ THE STATION PARAMETERS
      CALL GPARAM
      ENGBAL = 0.0
      FREWAT = 0.0
      LASUSD = 0
      NDYSND = 0
      ONTRES = 0.0
      PHASE = 0
      RCHRGO = RECHRG
      WEO = PREWEO
      BLOCK(1862) = TCDEFF
      BLOCK(1863) = COVDEN
      BLOCK(1869) = DECIDS(1)
      BLOCK(1870) = DECIDS(2)
      BLOCK(1871) = DECIDS(3)
C-----THE TIME RELATED PARAMETERS MUST BE DEFINED FOR USE IN SUBROUTINES
C----- CANVAP AND EVTRAN, EVEN THOUGH THEY REMAIN CONSTANT
      CDMAX2 = CDMAX/2.0
      IF(COVDEN) 10,20
   10 CONAV = 0.5
      CANREF = 0.9
      GO TO 30
   20 CONAV = 1.0
      CANREF = 0.5
C-----PRINT THE TITLE SHEET IF THE OUTPUT IS TO BE PRINTED
   30 IF(PLNOPT(1).NE.0) CALL TITLEN
      LINES = 0
C-----PERFORM THE SIMULATION ON EACH YEAR AS A UNIT.  READ THE SPECIFIED
C----- CONDITIONS CARD AND THE DATA FOR THE NEXT YEAR
   40 CALL GET1YR (IEND)
      IF(IEND.NE.0) GO TO 90
      BLOCK(1874) = PREWEO
      BLOCK(1875) = RECHRG
C-----PERFORM THE SIMULATION ON EACH DAY
      PPTNOW = 0.0
      ALLOW = 1.0
      DO 50 I = 1,3
   50 YRTOT(I) = 0.0
      DREADY = 0
      DO 80 NDAY = 1,372
      IF(TMAX(NDAY) + 1.E50) 60,80
C-----GENERATE THE DATA FOR THIS DAY
   60 CALL GENDAT
C-----MAKE THE PASS THROUGH THE WATER BALANCE ROUTINES
      CALL WATBAL (CALDEF,CDMAX,COVDEN,DREADY,ENGBAL,FREWAT,LASUSD,
     1 NDYSND,ONTRES,PHASE,PREWEO,RECHRG,SIMTM1(1),SIMTM1(2),SIMTM1(3),
     2 TCDEFF,TMPMLT,TRSHLD,VEGTYP,WILTPT)
C-----STORE THESE RESULTS
      WE(NDAY) = PREWEO
      RO(NDAY) = GENRO
      YRTOT(1) = YRTOT(1) + GENRO
      YRTOT(3) = YRTOT(3) + EVAPTR
C-----WATCH FOR THE MANDATORY ISOTHERMAL DATE
      IF(ISOTRM - NDAY) 80,70
   70 DREADY = -1
      CALDEF = 0.0
   80 CONTINUE
C-----GET THE BIMONTHLY FLOWS AND THE PEAK INFORMATION
```

```
      CALL G8(MDN
      ITEMP = PEKDAT
      CALL GPEAK (IDATE1)
C-----STORE THE FINAL INFORMATION AND WRITE THE RECORD
      BLDCK(1876) = YRTOT(1)
      8LOCK(1877) = YRTDT(3)
      8LOCK(1878) = RECHRG - RCHRGO
      RCHRGO = PECHRG
      8LOCK(1879) = PREWEO - WEO
      WED = PREWEQ
C-----NDTE THAT -PEKOAT- WAS REDEFINED 8Y SU8RDUTINE GPEAK, SD
C----- -8LOCK(1887)- MAY OR MAY NDT 8E THE SAME AS -8LDCK(1873)-
      8LDCK(1897) = PEKDAT
      PEKOAT = ITEMP
      8LDCK(1889) = IDATE1
      CALL PUTREC (16,8LDCK,1889)
C-----IF THE DUTPUT IS NOT TD 8E PRINTEO, GD DN TO THE NEXT YEAR. IF 1T
C----- IS, OUTPUT THE COMPILED RESULTS
      IF(PLNDPT(1).EQ.0) GD TD 40
      YRTOT(2) = PPT(371)
      CHANGR = 8LDCK(1878)
      CHANGW = BLDCK(1879)
      CALL DUTPT
      GD TD 40
C-----THE NDRMAL SIMULATION IS COMPLETE, SO END -SCRFIL-
   90 END FILE 16
  100 CALL EXTEND
      CALL CDRE (0)
C-----RETURN TD THE PRIMARY DVERLAY
      END
```

Subroutine EXTEND

```
      SU8RDUTINE EXTEND
C-----EXTEND (DR CDNTRACT) THE DATA 8ASE AND, IF SPECIFIEO, SAVE IT
      COMMDN DATIME(2),OECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECDVR,REGIDN(8),REGDPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECDVR,REGIDN,REGDPT,SAVE,SEDRN2
      COMMDN/E/CDN,ID(9),N8LDCK,DRIGYR
      INTEGER ORIGYR
      COMMDN/UTILTY/8LDCK(1889),CHANGR,CHANGW,DATE(2),OATES(4),LINES,
     1 NAME,NDAY,RCHRGC,RD(372),WE(372),WEO,YEAR,YRTDT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN 8IMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (8LDCK(2),TMAX(1)),(8LOCK(374),TMIN(1)),I8LOCK(746),
     1 PPT(1)),(8LDCK(1118),RAD(1)),(8LOCK(1490),ETO(1)),I8LDCK(1864),
     2 CDMAX),(8LDCK(1865),VEGTYP),(8LOCK(1866),TRSHLD),(8LDCK(1867),
     3 TMPMLT),(8LDCK(1868),WILTPT),(8LOCK(1871),DCDMAX),(8LOCK(1872),
     4 ISOTRM),(8LDCK(1873),PEKOAT),(8LOCK(1880),8IMNTH(1)),
     5 (8LDCK(1886),PEAKWE),(8LOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      CALL CORE (-1)
      MYEARS = NYEARS
      LINES.= 0
C-----IF THE FILE IS TO 8E SAVED, WRITE THE ID RECORD
      IF(SAVE) 10,30
   10 NSAVED = NSAVED + 1
      DD 20 I = 1,6
   20 ID(I) = PLUNIT(I)
      ID(7) = NYEARS
      ID(8) = DATIME(1)
      ID(9) = DATIME(2)
      CALL PUTREC (15,ID,9)
C-----PREPARE THE FILES.  IF DUTPUT IS WANTED, PRINT THE HEADING
   30 REWIND 16
      REWIND 11
      GD TD 60
C-----CDPY THE ORIGINAL DATA
   50 CALL PUTREC (11,8LDCK,1889)
      IF(SAVE.NE.0) CALL PUTREC (15,8LOCK,1889)
      YRNEXT = 8LDCK(1)
      MYEARS = MYEARS - 1
      IF(MYEARS) 110,110,60
   60 CALL GETREC (16,8LDCK,1889,IEND)
      IF(IEND) 70,50
C-----EXTEND THE DATA 8ASE.  START 8Y CDMPUTING THE NUM8ER DF YEARS IN
C----- THE DRIGINAL DATA 8ASE AND THE PRESENT PDSIT1ON OF THE SCRATCH
C----- FILE
   70 DRIGYR = NYEARS - MYEARS
      N8LDCK = DRIGYR + 1
C-----DEFINE THE DEGREE DF THE CDNSTANT TO 8E USED IN THE SELECTIDN
C----- PRDCESS
      CDN = 10.
      IF(DRIGYR.GE.10) CDN = CDN * 10.
      IF(DRIGYR.GE.100) CDN = CON * 10.
   90 CALL RANSEL
      YRNEXT = YRNEXT + 1.0
C-----SIMULATE THE NDRMAL CONDITIDNS
      CALL SIMNRM
      IF(PLNDPT(2).EQ.0) GD TD 100
      YRTDT(2) = PPT(371)
      CHANGR = 8LDCK(1878)
      CHANGW = BLOCK(1879)
      YEAR = YRNEXT
      CALL DUTPT1 (INT(8LDCK(1)))
  100 TEMP = 8LGCK(1)
      TEMP = 8LOCK(1)
      8LDCK(1) = YRNEXT
      CALL PUTREC (11,8LDCK,1889)
      IF(SAVE.NE.0) CALL PUTREC (15,8LDCK,1889)
      BLDCK(1) = TEMP
      MYEARS = MYEARS - 1
      IF(MYEARS) 110,110,90
  110 IF(SAVE.NE.0) END FILE 15
      CALL CORE (0)
C-----RETURN TD THE MAIN DVERLAY
      END
```

Subroutine GENDAT

```
      SUBROUTINE GENDAT
C-----GENERATE THE OATA FOR THIS SU8STATION
      COMMON/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,CDVDEN,OECIDS(3),DREADY,
     1 ENGRAL,ETDALY(12),FRACTN,FREWAT,ID,IM,IMN,IMX,IP,IY,LASUSD,LAT,
     2 NDYSNO,ONTRES,PEKPPT,PHASE,PDTENT(24),PDTRAD,PPTNDW,PREWEO,
     3 RADSU8,RECHRG,SIMTM1(3),SLOPE,SLPASP(24),SUMMER,TCOEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSU8,SLDPE,VARFMT
      COMMON/UTILTY/8LDCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGD,RD(372),WE(372),WEO,YEAR,YRTDT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN 8IMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EOUIVALENCE (BLOCK(2),TMAX(1)),(8LDCK(374),TMIN(1)),(8LDCK(746),
     1 PPT(1)),(BLDCK(1118),RAO(1)),(8LOCK(1490),ETO(1)),(8LDCK(1864),
     2 CDMAX),(BLDCK(1865),VEGTYP),(8LDCK(1866),TRSHLD),(8LDCK(1867),
     3 TMPMLT),(BLDCK(1868),WILTPT),(8LDCK(1871),DCDMAX),(8LDCK(1872),
     4 ISDTRM),(8LOCK(1873),PEKDAT),(8LDCK(188D),8IMNTH(1)),
     5 (8LDCK(1886),PEAKWE),(8LDCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      CDMMDN/WTP8AL/ALLDW,ETFRDM,EVAPTR,GENRO,PEAKEO,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      EOUIVALENCE (DATE(1),MONTH)
      DIMENSION DDFACT(26)
      DATA DDFACT/ .20, .35, .45, .51, .56, .59, .62, .64, .655, .67,
     1 .682, .69, .7D, .71, .715, .72, .722, .724, .726, .728, .73,
     2 .734, .738, .742, .746, .75/
C-----DEFINE THE UNADJUSTED PRECIP
      PPMSTR = PPT(NOAY) - PPTNDW
C-----ADJUST THE TEMPERATURES
      TMPMAX = AIRTMC(1) + (TMAX(NDAY) * AIRTMC(2))
      TMPMIN = AIRTMC(3) + (TMIN(NDAY) * AIRTMC(4))
      IF(TMPMAX - TMPMIN) 10,20,20
   10 TEMP = TMPMAX
      TMPMAX = TMPMIN
      TMPMIN = TEMP
C-----GET THE OATE AND PDTENTIAL RADIATION
   20 CALL GOATE (NDAY,DATE)
      CALL RADCMP ((OATE(1)*100)+OATE(2))
C-----COMPUTE THE INCOMING RAOIATION AT THE 8ASE STATION FROM THE
C----- PDTENTIAL 8Y THE DEGREE-DAY METHOO
      GD TD (50,50,50,50,60,70,70,70,60,50,50,50),MONTH
C-----DCTO8ER - APRIL, DEGREE DAYS = .44 * TEMPMAX - 15.9 (+1.0 FOR
C----- SU8SCRIPTING)
   50 DD = (0.44 * TMPMAX) - 14.9
      GD TD 100
C-----MAY ANO SEPTEM8ER, DEGREE OAYS = .53 * TEMPMAX - 19.5 (+1.0 FOR
C----- SU8SCRIPTING)
   60 OO = (0.53 * TMPMAX) - 18.5
      GD TD 100
C-----JUNE, JULY ANO AUGUST, DEGREE DAYS = .63 * TEMPMAX - 24.1 I+1.0
C----- FDR SU8SCRIPTING), EXCEPT ON DAYS WITH PRECIP.  DUR1NG THESE
C----- MONTHS, USE A CONSTANT 44 PERCENT ON PRECIP DAYS
   70 IF(PPMSTR) 90,90,80
   80 RADHRZ = PDTRAD * 0.44
      GD TD 150
   90 DD = (0.63 * TMPMAX) - 23.1
C-----WATCH FOR THE 8OUNDARY VALUES, O. ANO 25.  (WITH THE 1.0 ADDEO
C----- A8DVE, THE SU8SCRIPTS FOR THE TA8ULAR VALUES VARY FROM 1 TD 26)
  100 IF(DD - 1.0) 110,110,120
C-----USE THE FIRST TA8LE VALUE (ND INTERPOLATION IS NECESSARY)
  110 RADHRZ = PDTRAO * DDFACT(1)
      GO TD 150
  120 IF(DD - 26.0) 140,130,130
C-----USE THE LAST TA8LE VALUE (ND INTERPOLATION IS NECESSARY)
  130 RADHRZ = PDTRAD * DOFACT(26)
      GD TD 150
C-----THE SU8SCRIPT IS IN THE PRDPER RANGE.  D8TAIN THE 1NTERPDLATION
C----- FRACTION AND SU8SCRIPTS THRDUGH TRUNCATION OF -DD-
  140 J1 = OD
      DD1 = J1
      J = J1 + 1
C-----THE TERM (DD-DD1)/1.0 IS THE INTERPOLATION FRACTION
      RAOHRZ = POTRAD * (DDFACT(J1) + ((OOFACT(J) - DDFACT(J1)) * (DD -
     1 DO1)))
C-----ADJUST THE PDTENTIAL EVAPDTRANSPIRATION AS COMPUTED 8Y THE HAMON
C----- METHDD FOR AVAILA8LE RADIATION AS A PERCENT OF PDTENTIAL
  150 EVAPTR = ETDALY(MDNTH) * (RADHRZ/PDTRAO)
C-----ADJUST THE RADIATION AT THE 8ASE STATION FDR SLOPE AND ASPECT
      I = RADSU8 + 1
      IF((.GT.24) I = 1
      RADIN = RADHRZ * (SLPASP(RADSU8) + ((SLPASP(I) - SLPASP(RAOSU8))
     1 * FRACTN))
C-----ADJUST THE PRECIP TD ENSURE REACHING THE PEAK WATER EOUIVALENT
      IF(PPMSTR) 160,160,170
  160 PRECIP = D.0
      GD TO 200
  170 IF(PEKPPT - PPTNDW) 190,190,180
  180 PRECIP = PPMSTR * ((PEAKWE - PREWEQ)/(PEKPPT - PPTNDW))
      PEAKED = 0.0
      GD TO 200
C-----AFTER THE PEAK, ADJUST THE 8ASE STATIDN PRECIP BY THE CONSTANT
C----- SUMMER FACTOR
  190 PRECIP = PPMSTR * SUMMER
      PEAKED = 1.0
C-----OO NDT ALLOW INTERCEPTION IN JULY AND AUGUST
      ALLOW = 1.0
      IF(NOAY.GE.280.AND.NDAY.LE.341) ALLOW = 0.0
  200 IF(VEGTYP.NE.3.AND.VEGTYP.NE.4) GD TD 270
C-----CHECK THE DATE (8ETWEEN APRIL 1 AND OCTO8ER 15, IT IS PDSSI8LE TD
C----- HAVE FOLIAGE.  8UT OURING THE REMAINDER OF THE YEAR, IT IS
C----- ASSUMED THAT THE TREES ARE LEAFLESS)
      IF(NDAY.GE.187.DR.NDAY.LE.15) GD TD 230
C-----THE TREES SHOULO 8E LEAFLESS.  IF THEY ARE NDT, SWITCH TD THE
C----- LOWER COVER DENSITY
  210 IF(VEGTYP - 4) 220,270
  220 VEGTYP = 4
      GO TU 260
C-----THE FOLIAGE MAY 8E PRESENT, 8UT IF THE PACK WATER EOUIVALENT IS
C----- MORE THAN 5 INCHES, THE TREES ARE STILL ASSUMED TO 8E LEAFLESS
  230 IF(PREWEQ - 5.0) 240,240,210
C-----THE FOLIAGE SHOULD 8E PRESENT.  IF NOT, SWITCH TO THE HIGHER COVER
C----- DENSITY
  240 IF(VEGTYP - 3) 250,270
  250 VEGTYP = 3
  260 TCOEFF = SWITCH (TCOEFF,OECIOS(1))
      COVOEN = SWITCH (CDVDEN,OECIDS(2))
      CDMAX = SWITCH (CDMAX,OECIOS(3))
```

```
C-----STDRE THESE VALUES FDR DUTPUT TD THE BASIC FILE
  27C TMAX(NDAY) = TMPMAX
      TMIN(NDAY) = TMPMIN
      YRTOT(2) = YRTDT(2) + PRECIP
      PPTNDW = PPT(NDAY)
      PPT(NDAY) = YRTDT(2)
      RAD(NDAY) = RADIN
      ETG(NDAY) = EVAPTR
      RETURN
      END
```

Subroutine GET1YR

```
      SUBRDUTINE GET1YR (IEND)
C-----READ THE SPECIFIED CDNDITIDNS CARD AND THE DATA
      COMMDN DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNDPT(19),PLUNIT(6),
     1 RECDVR,REGIDN(8),REGDPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECDVR,REGIDN,REGDPT,SAVE,SEDRN2
      CDHMDN/N/ACCUH,AIRTMC(4),ASPECT,CALDEF,CDVDEN,DECIDS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTN,FREWAT,ID,IM,IMN,IMK,IP,IY,LASUSD,LAT,
     2 NDYSND,DNTRES,PEKPPT,PHASE,PDTENT(24),PDTRAD,PPTNDW,PREWEQ,
     3 RADSUB,RECHRG,SIMTM1(3),SLDPE,SLPASP(24),SUMMER,TCOEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSUB,SLDPE,VARFMT
      CDHHDN/UTILTY/BLDCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGD,RD(372),WE(372),WEO,YEAR,YRTDT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAK(372),TMIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(149D),ETD(1)),(BLOCK(1864),
     2 CDMAX),(BLDCK(1B65),VEGTYP),(BLDCK(1866),TRSHLD),(BLDCK(1867),
     3 TMPMLT),(BLDCK(1B68),WILTPT),(BLDCK(1871),DCDMAK),(BLDCK(1872),
     4 ISDTRM),(BLOCK(1B73),PEKDAT),(BLOCK(1BBD),BIMNTH(1)),
     5 (BLDCK(1BB6),PEAKWE),(BLDCK(1BBB),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      DIMENSIDN IDATES(6)
      READ (19) NAME,PEAKWE,IDATES
      IF(NAME.NE.1OHEND DF NAT) GD TD 10
      IEND = 1
      RETURN
   1D IEND = D
C-----CONVERT THE DATES TO THE PSEUDO-JULIAN FDRM  AND STDRE THE YEAR
C----- ALDNG WITH THE DECIMAL IO
      PEKDAT = JWYDAT (IDATES(1),IDATES(2))
      ISDTRM = JWYDAT (IDATES(4),IDATES(5))
      YEAR = IDATES(6)
      BLDCK(1) = FLDAT(YEAR) + DECMAL
C-----READ THE DATA AND CDMPARE THE YEARS
      CALL READAT
C-----DEFINE THE ACCUMULATED PRECIP UP TO THE DAY DF THE PEAK
   2D IF(TMAX(PEKDAT-1) + 1.E50) 40,3D
   3D PEKDAT = PEKDAT - 1
      GD TD 2D
   4D PEKPPT = PPT(PEKOAT-1)
      RETURN
      END
```

Subroutine GPARAM

```
      SUBRDUTINE GPARAM
C-----READ THE STATIDN PARAMETERS FRDM THE PRDDFREAD FILE
      CDMMDN DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECDVR,REGION(B),REGDPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECOVR,REGIDN,REGDPT,SAVE,SEDRN2
      CDMMDN/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,COVOEN,DECIOS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTN,FREWAT,IO,IM,IMN,IMX,IP,IY,LASUSD,LAT,
     2 NDYSND,DNTRES,PEKPPT,PHASE,PDTENT(24),POTRAD,PPTNDW,PREWEQ,
     3 RADSUB,RECHRG,SIMTM1(3),SLDPE,SLPASP(24),SUMMER,TCOEFF,
     4 VARFHT(7),VARIN(6)
      INTEGER ASPECT,OREADY,PHASE,RADSUB,SLOPE,VARFMT
      CDMMDN/UTILTY/BLDCK(1B89),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGD,RD(372),WE(372),WED,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN BIMNTH(6),ETO(372),PPT(372),RAO(372),TMAK(372),TMIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(149D),ETD(1)),(BLOCK(1B64),
     2 CDMAX),(BLDCK(1B65),VEGTYP),(BLDCK(1866),TRSHLO),(BLDCK(1B67),
     3 TMPMLT),(BLDCK(1868),WILTPT),(BLOCK(1B71),DCDMAK),(BLDCK(1872),
     4 ISDTRM),(BLDCK(1B73),PEKDAT),(BLDCK(1880),BIMNTH(1)),
     5 (BLDCK(1886),PEAKWE),(BLDCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      READ (19) TCDEFF,CDVDEN,CDMAX,VEGTYP,TRSHLD,TMPMLT,WILTPT,DECIDS,
     1 LAT,ASPECT,SLDPE,SIMTM1(2),PREWED,RECHRG,ETDALY,AIRTMC,SUMMER
C-----IF THE TRANSMISSIVITY CDEFFICIENTS ARE NDT SPECIFIED, CDMPUTE THEM
      IF(TCDEFF.LE.C.D) TCDEFF = TC (COVDEN)
      IF(DECIDS(1).LE.D.D) DECIDS(1) = TC (DECIDS(2))
C-----CDNVERT THE PACK TEMPERATURE TD CALORIE DEFICIT (AS A PDSITIVE
C----- DUANTITY), AND DEFINE THE GROUND TEMPERATURE FDR THE SIMULATIDN
      CALDEF = -SIMTM1(2) * PREWEQ * 1.27
      SIMTM1(1) = SIMTM1(2)
      SIMTM1(3) = -1.5
C-----READ THE RADIATIDN, THEN THE VARIABLE FORMAT
      READ (19) POTENT,SLPASP
      READ (19) VARFMT,NFILE,IM,ID,IY,IMK,IMN,IP
C-----POSITIDN THE UNEDITEO FILE AND READ THE FIRST CARD
      CALL SKPFIL (NFILE)
      READ (10,VARFMT) VARIN
      RETURN
      END
```

Subroutine OUTPT1

```
      SUBRUUTINE OUTPT1 (YRFROM)
C-----DUTPUT THE COMPILED RESULTS AND WRITE THE BASIC DATA DN THE FILE
      COMMDN DATIHE(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGDPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECDVR,REGIDN,REGOPT,SAVE,SEDRN2
      COMMDN/UTILTY/BLDCK(1BB9),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGC,RD(372),WE(372),WED,YEAR,YRTDT(3)
      INTEGER DATE,DATES,YEAR
      DIHENSION BIMNTH(6),ETD(372),PPT(372),RAD(372),TMAK(372),TMIN(372)
      EDUIVALENCE (BLDCK(2),TMAX(1)),(BLDCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(I)),(BLDCK(1118),RAD(1)),(BLOCK(149D),ETO(1)),(BLOCK(1864),
     2 CDHAX),(BLDCK(1865),VEGTYP),(BLDCK(1866),TRSHLD),(BLDCK(1867),
     3 TMPMLT),(BLDCK(1868),WILTPT),(BLDCK(1B71),DCDMAK),(BLDCK(1B72),
     4 ISOTRM),(BLDCK(1873),PEKDAT),(BLDCK(18BD),BIHNTH(1)),
     5 (BLOCK(1BB6),PEAKWE),(BLOCK(188B),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      INTEGER YRFRDM
C-----CHECK THE LINE CDUNTER
      IF(LINES) 10,1D,20
   1D WRITE (6,91D) REGIDN,DATIME,PLUNIT
  910 FDRMAT(*1*BA10,32X2A1D/1X6A10,45X*EXTENDED NATURAL CDNDITIDNS*/
     1 *D        *
     1  *YEAR     - - - -BIMONTHLY GENERATED RUNDFF- - - -     - - - - - - -
     2YEARLY - - - - - - -     9/30    - - - - - - - - PEAK - - - - - - - -*/
     3 *         *
     3  *         APRIL    MAY     MAY      JUNE    JUNE    JULY      GEN
     4       CHANGE CHANGE    RECH                         7-DAY*/
     5 * (FRDH)*
     5  *         16-3D    1-15   16-31    1-15  16-3D    1-15       RD     PPT
     6    ET    RECH    W.E.     RED    W.E.    DATE   GENRD       DATES*/)
      LINES = 5D
C-----PRINT THE LINE
   2D WRITE (6,92D) YRFRDM,YEAR,BIMNTH,YRTDT,CHANGR,CHANGW,RCHRGD,
     1 PEAKWE,DATE,PEAKRD,DATES
  92D FDRMAT(* (*I3,*)*2XI3,1X13F7.2,2KI2,*/*I2,F7.2,2(2KI2,*/*I2))
      LINES = LINES - 1
      RETURN
      END
```

Subroutine RADCMP

```
      SUBRDUTINE RADCMP (MMDD)
C-----CDMPUTE THE PDTENTIAL RADIATIDN AT THE BASE STATIDN
      CDMMDN/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,COVDEN,DECIDS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTN,FREWAT,ID,IM,1MN,IMX,IP,IY,LASUSO,LAT,
     2 NDYSND,DNTRES,PEKPPT,PHASE,PDTENT(24),PDTRAD,PPTNDW,PREWEQ,
     3 RADSUB,RECHRG,SIMTM1(3),SLOPE,SLPASP(24),SUMMER,TCDEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSUB,SLDPE,VARFMT
      CDMMDN/UTILTY/BLDCK(1BB9),CHANGR,CHANGW,DATE(2),OATES(4),LINES,
     1 NAME,NDAY,RCHRGD,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EDUIVALENCE (BLOCK(2),TMAK(1)),(BLOCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(149D),ETO(1)),(BLDCK(1B64),
     2 CDMAX),(BLDCK(1B65),VEGTYP),(BLDCK(1866),TRSHLD),(BLDCK(1B67),
     3 TMPMLT),(BLDCK(1B68),WILTPT),(BLDCK(1B71),DCDMAK),(BLDCK(1B72),
     4 1SDTRM),(BLOCK(1873),PEKDAT),(BLDCK(188D),BIMNTH(1)),
     5 (BLDCK(1BB6),PEAKWE),(BLDCK(1BBB),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      DIMENSIDN BETWEN(24),NDATE(24)
      DATA BETWEN/13., 15., 13., 15., 14., 14., 15., 14., 15., 14.,
     1 21., 2D., 15., 14., 15., 15., 14., 15., 14., 14., 14., 14., 19.,
     2 19./
      DATA NDATE/ 11D,123,207,22D,3D7,321,4D4,419,5D3,51B,6DI,622,712,
     1 727,B10,B25,909,923,1DD8,1022,1105,1I19,1203,1222/
C-----PLACE THIS DATE WITH RESPECT TO THE TABLES
      DD 1D I = 1,24
      IF(NDATE(I) - MMDD) 1D,8D,20
   1D CDNTINUE
C-----A NORMAL TERMINATIDN DF THE DD LDDP MEANS THAT THIS DATE FALLS
C----- BETWEEN 12/23 AND 12/31, INCLUSIVE.  USING THE ARRAY IN CIRCULAR
C----- FASHIDN, 1/1D (SUBSCRIPT 1) IS THE CDNTRDLLING DATE
      I = 1
      GD TD 30
C-----THIS DATE FALLS BETWEEN THE DNES AT LDCATIONS I AND I-1.  IF I IS
C----- 1, USE 24 FDR I-1 SINCE THE ARRAY IS CIRCULAR
   2D RADSUB = I - 1
      IF(RADSUB) 3D,30,40
   30 RADSUB = 24
C-----DBTAIN THE INTERPDLATION FRACTIDN.  START BY DETERMINING IF
C----- THIS DATE FALLS IN THE SAME MDNTH AS THAT AT LDCATIDN I DR I-1
   40 IF(DATE(1) - (NDATE(RADSUB)/10D)) 60,50,6D
C-----IT IS THE SAME AS I-1 AND IT IS LARGER, SO SUBTRACT THE I-1 DATE
C----- TD DBTAIN THE NUMBER DF DAYS TD BE USED FDR INTERPDLATING
   5D DAYS = HMDD - NDATE(RADSUB)
      GD TD 70
C-----IT IS THE SAME AS I, BUT IT IS SMALLER, SD SUBTRACT IT FRDM THE I
C----- DATE.  THEN SUBTRACT THE RESULT FRDM THE DAYS BETWEEN I AND I-1
C----- TD DBTAIN THE NUMBER DF DAYS TD BE USED FDR INTERPDLATING
   60 DAYS = NDATE(I) - MMDD
      DAYS = BETWEN(RADSUB) - DAYS
C-----CDMPUTE THE INTERPDLATIDN FRACTIDN
   7D FRACTN = DAYS/BETWEN(RADSUB)
      PDTRAD = PDTENT(RADSUB) + (PDTENT(I) - PDTENT(RADSUB)) * FRACTN
      RETURN
C-----THIS DATE IS IN THE TABLE - ND INTERPDLATION IS NECESSARY
   8D FRACTN = 0.0
      RADSUB = I
      PDTRAD = PDTENT(I)
      RETURN
      END
```

Subroutine RANSEL

```
      SUBROUTINE RANSEL
C-----RANDOMLY SELECT THE NEXT YEAR FRDM THE DRIGINAL DATA BASE
      CDMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECDVR,REGION,REGOPT,SAVE,SEDRN2
      COMHON/E/CON,ID(9),NBLOCK,ORIGYR
      INTEGER DRIGYR
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGC,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
```

```
      DIMENSION BIMNTM(6),ETD(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(1)),(BLDCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(1490),ETD(1)),(BLDCK(1864),
     2 CDMAX),(BLDCK(1865),VEGTYP),(BLDCK(1866),TRSMLD),(BLDCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLDCK(1871),DCDMAX),(BLDCK(1872),
     4 ISOTRM),(BLDCK(1873),PEKDAT),(BLDCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLDCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
C-----GET A RANDDM NUMBER BETWEEN 1 AND -DRIGYR- (SUBRDUTINE RM2
C----- RETURNS A REAL VALUE BETWEEN 0 AND 1)
   10 CALL RN2 (SEDRN2,RANDDM)
      N = RANDDM * CDN
      IF(1.GT.N.DR.N.GT.DRIGYR) GD TO 10
C-----COMPARE TMIS NUMBER WITH THE CURRENT BLDCK.  IF THEY ARE THE SAME,
C----- ND FURTMER READING IS NECESSARY.  IF THE CURRENT BLDCK NUMBER IS
C----- LARGER, THE FILE MUST BE REWOUND BEFDRE THE SEARCH BEGINS
      IF(N - NBLOCK) 20,40,30
   20 REWIND 16
      NBLDCK = 0
C-----BYPASS THE BLOCKS UNTIL THE SPECIFIED NUMBER IS FDUND
   30 CALL GETREC (16,BLDCK,1889,IEND)
      NBLDCK = NBLDCK + 1
      IF(N - MBLDCK) 30,40
   40 RETURN
      ENO
```

Subroutine READAT

```
      SUBRDUTINE READAT
C-----READ THE YEAR DF DATA AND STORE IT
      COMMDN/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,COVDEN,DECIDS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTM,FREWAT,IO,IM,IMM,IMX,IP,IY,LASUSO,LAT,
     2 NDYSND,DMTRES,PEKPPT,PHASE,PDTENT(24),PDTRAD,PPTNOW,PREWEQ,
     3 RADSUB,RECHRG,SIMTM1(3),SLDPE,SLPASP(24),SUHMER,TCDEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSUB,SLDPE,VARFMT
      COMMDN/UTILTY/BLDCK(1889),CHANGR,CHANGM,OATE(2),OATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,OATES,YEAR
      DIMENSIDN BIMNTH(6),ETD(372),PPT(372),RAO(372),TMAX(372),TNIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(I)),(BLDCK(374),TNIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(1490),ETD(1)),(BLDCK(1864),
     2 CDMAX),(BLDCK(1865),VEGTYP),(BLDCK(1866),TRSHLD),(BLDCK(1867),
     3 TMPMLT),(BLDCK(1868),WILTPT),(BLDCK(1871),DCDMAX),(BLDCK(1872),
     4 ISDTRM),(BLDCK(1873),PEKDAT),(BLDCK(1880),BIMNTH(1)),
     5 (BLDCK(1886),PEAKWE),(BLDCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      OATA MDNTH/0/
      IF(MDNTH.EQ.-999999) GD TD 20
C-----FIND THE FIRST CARD FDR THIS YEAR
   10 MOMTH = VARIN(IM)
      IYEAR = VARIN(IY)
      IF((IYEAR+1.EO.YEAR.ANO.MDNTH.GE.10).DR.(IYEAR.EO.YEAR.AND.WONTH.
     1 LE.9)) GD TD 30
      READ (1D,VARFMT) VARIN
      IF(EDF(10)) 20,10
   20 WRITE (6,91D) YEAR
  910 FDRMAT(*OUNABLE TD FIND YEAR*I4,* DN -UNEDIT-.  JDB ABDRTED*)
      CALL ABDRT
C-----STDRE THE LARGE VALUE IN THE MAXIWUN TEMPERATURE SD MISSING DR
C----- NDNEXISTENT DAYS (FEB 30) CAN BE DETECTED
   30 DD 4D I = 1,372
   40 THAX(I) = -1.E50
C-----CDNVERT TME DATE TD THE PSEUDD-JULIAN FDRN AND STORE THE DRIVING
C----- VARIABLES
   50 IDAY = VARIN(IO)
      J = JWYDAT(HDNTH,IDAY)
      TMAX(J) = VARIN(IMX)
      TMIN(J) = VARIM(IMN)
      PPT(J) = VARIN(IP)
C-----READ THE NEXT CARD AND IF TME WATER YEAR DDES NOT CHANGE, GD BACK
C----- TD STORE IT
      REAO (10,VARFMT) VARIN
      IF(EDF(10)) 70,60
   60 HDNTH = VARIN(IM)
      IYEAR = VARIN(IY)
      IF((IYEAR+1.ED.YEAR.AND.MDNTH.GE.10).DR.(IYEAR.EO.YEAR.AND.MONTH.
     1 LE.9)) GD TD 5D
      GD TD 80
   70 HDNTH = -999999
C-----THIS YEAR IS CDMPLETE - ACCUMULATE THE PRECIP
   8D ACCUM = D.0
      NDAY = 0
      OD 100 I = 1,372
      IF(TMAX(I) + 1.E50) 9D,100
   90 ACCUM = ACCUM + PPT(I)
      PPT(I) = ACCUH
      NDAY = NOAY + 1
  100 CDNTINUE
      IF(NDAY.GE.364.ANO.NDAY.LE.367) RETURN
      WRITE (6,920) YEAR,NDAY
  92D FDRMAT(*  NDTE - YEAR*I4,* HAS*I4,* DAYS*)
      RETURN
      ENO
```

Subroutine SIMNRM

```
      SUBROUTIME SIMNRM
C-----PERFORM THE NORMAL SIMULATIOW FDR A YEAR CREATED DURING THE
C----- EXTEMSIDN OF THE DATA BASE
      CDMMON DATIME(2),DECMAL,NRMANG,NSAVED,WYEARS,PLMOPT(19),PLUMIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIHE,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMHDN/N/ACCUH,AIRTMC(4),ASPECT,CALDEF,CDVDEM,DECIDS(3),DREADY,
     1 ENGBAL,ETDALY(12),FRACTN,FREWAT,ID,IN,IPM,IMX,IP,IY,LASUSD,LAT,
     2 NDYSMO,OMTRES,PEKPPT,PMASE,POTEMT(24),POTRAD,PPTMOW,PREWEQ,
     3 RADSUB,RECHRG,SIMTM1(3),SLOPE,SLPASP(24),SUMMER,TCOEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,DREADY,PHASE,RADSUB,SLOPE,VARFMT
      COMMDM/TIME/CAWREF,CDWAX2,CDNAV
      COMMOW/UTILTY/BLOCK(1889),CHAWGR,CHAWGW,DATE(2),DATES(4),LIWES,
     1 WAME,MDAY,RCHRG0,RD(372),WE(372),WE0,YEAR,YRTDT(3)
      IWTEGER DATE,DATES,YEAR
      DIMEWSIOW BIWNTM(6),ET0(372),PPT(372),RAD(372),TMAX(372),TMIM(372)
      EDUIVALEWCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIM(1)),(BLOCK(746),
     1 PPT(1)),(BLDCK(1118),RA0(1)),(BLOCK(1490),ET0(1)),(BLOCK(1864),
     2 CDMAX),(BLOCK(1865),VEGTYP),(BLCCK(18E6),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCDMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMMTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      IWTEGER PEKDAT,VEGTYP
      COMMDN/WTRBAL/ALLOW,ETFROM,EVAPTR,GEMRO,PEAKED,PRECIP,RADIM,
     1 RADLWN,RADSWW,TMPMAX,TMPNIM,WATRIW
C-----STORE THE IWITIAL CONDITIOWS AND ZERD THE ACCUMULATDRS
      BLDCK(1874) = PREWEO
      BLOCK(1875) = RECHRG
      YRTDT(1) = 0.0
      YRTOT(3) = 0.0
      DREADY = 0
      PPTNOW = 0.0
      PEAKED = 0.0
      DO 30 WDAY = 1,372
      IF(TMAX(WOAY) + 1.E50) 10,30
C-----DEFINE TME DRIVIWG VARIABLES
   10 TWPMAX = TMAX(WDAY)
      TMPMIN = TNIW(NDAY)
      PRECIP = PPT(NOAY) - PPTNOW
      PPTMOW = PPT(NDAY)
      EVAPTR = ET0(WDAY)
      RADIM = RAD(WDAY)
C-----DO WOT ALLOW IWTERCEPTION IW JULY AND AUGUST
      ALLOW = 1.0
      IF(NDAY.GE.280.AND.WDAY.LE.341) ALLOW = 0.0
      IF(WDAY.EO.PEKDAT) PEAKED = 1.0
C-----WATCM FOR DECIDUOUS FOREST AWD TMEIR CHANGE OF SEASONS
      IF(VEGTYP.EQ.3.OR.VEGTYP.EQ.4) GO TO 40
   15 CDWTINUE
C-----NAKE TME PASS TMROUGM THE WATER BALAWCE ROUTIWES
      CALL WATBAL (CALDEF,COMAX,COVDEW,DREADY,ENGBAL,FREWAT,LASUSD,
     1 NDYSNO,ONTRES,PMASE,PREWEO,RECMRG,SIWTM1(1),SIWTN1(2),SIWTN1(3),
     2 TCOEFF,TWPMLT,TRSMLD,VEGTYP,WILTPT)
C-----STORE TMESE RESULTS
      WE(NOAY) = PREWEO
      RO(NDAY) = GENRD
      YRTOT(1) = YRTOT(1) + GEWRO
      YRTOT(3) = YRTOT(3) + EVAPTR
C-----WATCN FOR THE MAWDATORY ISOTHERMAL DATE
      IF(ISOTRN - NDAY) 30,20
   20 DREADY = -1
      CALDEF = 0.0
   30 COWTINUE
C-----GET TNE BIMONTNLY FLOWS AWD TME PEAK IWFORNATION
      CALL GBIWON
      ITEWP = PEKDAT
      CALL GPEAK(IDATE1)
C-----STORE THE FINAL INFORMATION
      BLOCK(1876) = YRTDT(1)
      BLOCK(1877) = YRTOT(3)
      BLOCK(1878) = RECHRG - RCMRG0
      RCHRG0 = RECHRG
      BLOCK(1879) = PREWEO - WE0
      WE0 = PREWEQ
C-----NOTE TNAT -PEKDAT- WAS REDEFINED BY SUBROUTINE GPEAK, SD
C----- -BLOCK(1887)- NAY OR NAY NOT BE THE SANE AS -BLOCK(1873)-
      BLOCK(1887) = PEKDAT
      PEKDAT = ITENP
      BLOCK(1889) = IDATE1
      RETURN
C-----WATCH FOR THE CHANGE DF SEASONS FOR DECIDUOUS FORESTS
   40 CONTINUE
C-----CHECK TME DATE (BETWEEN APRIL 1 AND OCTOBER 15, IT IS POSSIBLE TC
C----- HAVE FOLIAGE.  BUT OURING THE RENAIMDER OF THE YEAR, IT IS
C----- ASSUNEO THAT THE TREES ARE LEAFLESS)
      IF(NDAY.GE.187.OR.NDAY.LE.15) GO TO 230
C-----THE TREES SHOULD BE LEAFLESS.  IF THEY ARE NOT, SWITCH TO THE
C----- LOWER COVER DENSITY
  210 IF(VEGTYP - 4) 220,270
  220 VEGTYP = 4
      GO TO 260
C-----THE FDLIAGE NAY BE PRESENT, BUT IF THE PACK WATER EOUIVALENT IS
C----- NORE TNAN 5 INCHES, THE TREES ARE STILL ASSUMED TO BE LEAFLESS
  230 IF(PREWEO - 5.0) 240,240,210
C-----THE FOLIAGE SHOULO BE PRESENT.  IF MOT, SWITCH TD THE HIGHER COVER
C----- DENSITY
  240 IF(VEGTYP - 3) 250,270
  250 VEGTYP = 3
  260 TCOEFF = SWITCH (TCOEFF,DECIDS(1))
      COVDEN = SWITCH (COVDEN,DECIDS(2))
      CDNAX = SWITCH (CDNAX,DECIDS(3))
  270 CONTINUE
      GD TO 15
      END
```

Subroutine SKPFIL

```
      SUBROUTINE SKPFIL (NFILE)
C-----SKIP FILES DN TME UNEDITED DATA FILE
      REWIND 10
      MFILE = NFILE - 1
      IF(MFILE) 50,50,10
   1D DD 40 I = 1,MFILE
      READ (10,910)
  910 FDRMAT(1X)
C-----AN ENO OF FILE DN THE FIRST READ INDICATES AN END DF INFORMATIDN
      IF(EOF(10)) 20,30
   20 J = I - 1
      WRITE (6,920) J,NFILE
  920 FDRMAT(*OTMERE ARE DNLY*I3,* FILES DN -UNEDIT- BUT ACCDRDING TD TM
     1E VARIABLE FDRMAT CARO, THE DATA IS DN FILE*I3,* - JDB ABDRTED*)
      CALL ABDRT
C-----BYPASS THE REMAINDER OF TME FILE
   30 READ (10,910)
```

```
      IF(EOF(10)) 40,30
   40 CONTINUE
   50 RETURN
      END
```

Subroutine TITLEN

```
      SUBROUTINE TITLEN
C-----PRINT THE TITLE SHEET
      COMMON OATIME(2),DECMAL,NRMANG,NSAVED,NYFARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER OATIME,PLNOPT,PLUNIT,RECOVR,REGION,PEGOPT,SAVE,SEDRN2
      COMMON/N/ACCUM,AIRTMC(4),ASPECT,CALDEF,COVOEN,OECIDS(3),DREAOY,
     1 ENGBAL,ETOALY(12),FRACTN,FREWAT,ID,IM,IMN,IMX,IP,IY,LASUSD,LAT,
     2 NOYSND,ONTRES,PEKPPT,PHASE,POTENT(24),POTRAO,PPTNOW,PREWEO,
     3 RADSUR,RECHRG,SIMTM1(3),SLOPE,SLPASP(24),SUMMER,TCDEFF,
     4 VARFMT(7),VARIN(6)
      INTEGER ASPECT,OREAOY,PHASE,RAOSUB,SLOPE,VARFMT
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NOAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,OATES,YEAR
      OIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EOUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(8LOCK(746),
     1 PPT(1)),(8LOCK(1118),RAD(1)),(8LOCK(1490),ETO(1)),(8LOCK(1864),
     2 CDMAX),(BLOCK(1865),VEGTYP),(8LOCK(1866),TRSHLD),(8LOCK(1867),
     3 TMPMLT),(8LOCK(1868),WILTPT),(8LOCK(1871I,DCDMAX),(8LOCK(1872),
     4 (SOTRM),(BLOCK(1873),PEKDAT),(8LOCK(1880),8IMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(8LOCK(1888),PEAKRO)
      INTEGER PEKOAT,VEGTYP
      INTEGER TABLE1(13),TABLE2(13I
      OATA TABLE1/6HJUN 22,6HJUN 1 ,6HMAY 18,6HMAY 3 ,6HAPR 19,6HAPR 4 ,
     1 6HMAR 21,6HMAR 7 ,6HFE8 20,6HFE8 7 ,6HJAN 23,6HJAN 10,6H      /
      DATA TABLE2/6H      ,6HJUL 12,6HJUL 27,6HAUG 10,6HAUG 25,6HSEP 9 ,
     1 6HSEP 23,6HOCT 8 ,6HOCT 22,6HNOV 5 ,6HNOV 19,6HDEC 3 ,6HDEC 22/
      WRITE (6,910) PLUNIT,DATIME
  910 FORMAT(*1*6A10,52X2A10/115X*NATURAL CONOITIONS*)
      TMPMLF = (TMPMLT * 1.8) + 32.
      WRITE (6,920) TCOEFF,COVDEN,CDMAX,VEGTYP,TRSHLO,TMPMLF,WILTPT
  920 FORMAT(*OSUBSTATION CONSTANTS*/* TRANSMISSIVITY COEFF*10XF10.2/
     1 * COVER DENSITY        *10XF10.2/* MAXIMUM COVER DEN   *10XF10.2/
     2 * VEGETATION TYPE      *10XI10  /* REFLECTIVITY THRSHLO*10XF10.2/
     3 * MELT THRESHOLD       *10XF10.2/* WILTING POINT       *10XF10.2)
      IF(VEGTYP.EO.3) WRITE (6,930) DECIOS
  930 FORMAT(* DECIDUOUS WINTER TC *10XF10.2/
     1 * DECIDUOUS WINTER CD *10XF10.2/* DECIDUOUS WNTR COMAX*10XF10.2)
      WRITE (6,940) SIMTM1(2),PREWEO,RECHRG
  940 FORMAT(*OINITIAL CONDITIONS*/
     1 * AVERAGE PACK TEMP.  *10XF10.2/* PACK WATER EOUIV.   *10XF10.2/
     2 * RECHARGE REOUIREMENT*10XF10.2)
      WRITE (6,950) LAT,ASPECT,SLOPE,(TABLE1(I-11),TABLE2(I-11),
     1 POTENT(I),SLPASP(I),I=12,24)
  950 FORMAT(*OLATITUDE =*I3,*, ASPECT = *A3,*, SLOPE =*I3/
     1 *OPOTENTIAL RADIATION INCIDENT TO HORIZONTAL SURFACE AND ADJUSTME
     1NT FACTORS FOR ASPECT AND SLOPE*/22X*LY    ADJUST*,13(/1XA6,1XA6,
     3 2F10.2))
      RETURN
      END
```

Program MANAGE

```
      OVERLAY (OLAYS,2,2)
      PROGRAM MANAGE
C-----PERFORM THE MANAGEMENT STRATEGY SIMULATION AND CREATE THE PLANNING
C----- UNIT FILE
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6I,
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/M/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8I,EXPK(8),EXPK1(8),FREWAT(8I,LAST1,
     2 LASUSD(8),LCOPY(14),NDYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),RDMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8I,SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/TIME/CANREF,CDMAX2,CDNAV
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NOAY,RCHRGO,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,OATES,YEAR
      DIMENSION BIMNTH(6I,ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EOUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAO(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCDMAX),(BLOCK(1872),
     4 (SOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
C-----NOTE - THE DIMENSION OF -FORNXT- MUST BE EOUAL TO THE LENGTH OF
C----- COMMON BLOCK /M/ AND THAT LENGTH MUST BE STORED IN -L4NXT-
      DIMENSION FORNXT(313)
      EOUIVALENCE (ALTYR(1),FORNXT(1))
      CALL CORE (-1)
      L4NXT = 313
      REWIND 17
      REWIND 18
      WRITE (18,900) PLUNIT,DATIME
  900 FORMAT(*1*6A10,52X2A10/*OMANAGEMENT STRATEGY DESCRIPTION*)
      LAST1 = -1
      SEEDYR(1) = 9999
C-----MAKE A PASS THROUGH THE DATA TO TRANSFER THE YEARLY RESULTS OF THE
C----- NORMAL SIMULATION TO THE PLANNING UNIT FILE
      CALL NORM
C-----READ THE FIRST MANAGEMENT PLAN CARD - IF THERE IS NONE, THIS UNIT
C----- IS NOT MANAGED, BUT WAS INCLUDED ONLY AS PART OF A REGION
      NPLAN = 0
      CALL RDPLAN
      IF(NEXTYR.EO.9999) GO TO 110
C-----BYPASS THE DATA ON THE BASIC FILE UNTIL THE FIRST YEAR OF THE
C----- MANAGEMENT PLAN IS FOUND
      CALL BYPASS
C-----DEFINE THE NATURAL RESPONSE UNIT
      CALL NATURL
C-----DEFINE AN ALTERED RESPONSE UNIT
   10 CALL DEFRU
C-----PRINT THE TITLE PAGE IF THE OUTPUT IS TO BE PRINTED
      IF(PLNOPT(3).NE.0) CALL TITLEM
      LINES = 0
C-----SIMULATE ONE YEAR
   20 CALL SIMIYR
C-----GET THE CHANGE IN THE RECHARGE REQUIREMENT AND IN THE PACK WATER
C----- EOUIVALENT AND WRITE THE INFORMATION ON THE PLANNING UNIT FILE
      RCHRG = 0.0
      DO 30 I = 1,NUNIT
   30 RCHRG = RCHRG + (RECHRG(I) * RUWT(I))
      CHANGR = RCHRG - RCHRGO
      RCHRGO = RCHRG
      CHANGW = WE(371) - WEO
      WEO = WE(371)
C-----GET THE BIMONTHLY FLOWS AND THE PEAK INFORMATION
      CALL GBIMON
      CALL GPEAK (IDATE1)
      DATE1 = PEKDAT
      DATE2 = IDATE1
      WRITE (12,910) NPLAN,BLOCK(1),YRTOT,CHANGR,CHANGW,BIMNTH,PEAKWE,
     1 DATE1,PEAKRD,DATE2
  910 FORMAT(I2,16F6.2)
C-----IF SPECIFIED, OUTPUT THE COMPILED RESULTS
      IF(PLNOPT(3).EO.0) GO TO 40
      CALL OUTPT
C-----DETERMINE THE EFFECTS OF THE TIME TRENDS
   40 CALL TRENDS
C-----IF THIS IS THE YEAR JUST BEFORE THE NEXT MANAGEMENT PLAN, STORE
C----- THE PRESENT MODEL CONDITIONS ON THE SCRATCH FILE TO PROVIDE THE
C----- STARTING POINT FOR THE NEXT PLAN
      IF(YEAR + 1 - NEXTYR) 60,50
   50 REWIND 16
      CALL PUTREC (16,FORNXT,L4NXT)
C-----READ THE NEXT YEAR
   60 CALL GETREC (11,BLOCK,1889,IEND)
      IF(IEND.EO.0) GO TO 20
C-----END OF FILE - IF THERE IS ANOTHER MANAGEMENT PLAN, READ THE
C----- INITIAL CONDITIONS BACK FROM THE SCRATCH FILE, BYPASS THE DATA
C----- TAPE UP TO THE FIRST YEAR, AND GO ON TO THE NEXT MANAGEMENT PLAN
      IF(NEXTYR - 9999) 70,80
   70 CALL BYPASS
      REWIND 16
      CALL GETREC (16,FORNXT,L4NXT,IEND)
      GO TO 10
C-----IF SPECIFIED, COPY THE TIME TRENDS FILE
   80 IF(PLNOPT(4).EO.0) GO TO 110
      REWIND 17
      GO TO 100
   90 WRITE (6,990) LCOPY
  990 FORMAT(13A10,A6)
  100 READ (17,990) LCOPY
      IF(EOF(17)) 110,90
C-----RETURN TO THE PRIMARY OVERLAY
  110 CONTINUE
      CALL CORE (0)
      END
```

Subroutine BYPASS

```
      SUBROUTINE BYPASS
C-----BYPASS THE DATA ON THE BASIC FILE UNTIL THE FIRST YEAR OF THE
C----- MANAGEMENT PLAN IS FOUND
      COMMON/M/ALTYR(8),BOUND(6,8),CALOEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSD(8),LCOPY(14),NDYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,OREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EOUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 CDMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),OCDMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      INTEGER PEKOAT,VEGTYP
      REWIND 11
C-----GET A YEAR
   10 CALL GETREC (11,BLOCK,1889,IEND)
      IF(IEND) 20,30
   20 WRITE (6,910) NEXTYR
  910 FORMAT(*OTHE EXTENDED DATA FILE ENDED BEFORE MANAGEMENT PLAN YEAR*
     1 I4,* WAS FOUND - JOB ABORTEO*)
      CALL ABORT
   30 IF(NEXTYR - INT(BLOCK(1))) 40,50,10
   40 JYEAR = INT(OLOCK(1))
      WRITE (6,920) NEXTYR,JYEAR
  920 FORMAT(*OTHE EXTENDED DATA FILE DOES NOT CONTAIN MANAGEMENT PLAN Y
     1EAR*I4,*.  THE NEXT YEAR ON THE FILE IS*I4,* - JOB ABORTEO*)
      CALL ABORT
   50 YEAR = BLOCK(1)
      RETURN
      END
```

Subroutine DEFRU

```
      SUBROUTINE DEFRU
C-----DEFINE A RESPONSE UNIT (OR REDEFINE ONE PREVIOUSLY DEFINED)
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/M/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
```

```
   2 LASUSO(B),LCOPY(14),NDYSNO(B),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(B),
   3 PARAM(9),PHASE(B),PH1SO(8),PREWEQ(B),RDIST(B),ROMAX(B),RECHRG(B),
   4 REGRDW(2,B),RUNUM(B),RUWT(8),SEOINC,SEEOAT(2),SEEOYR(2),
   5 SIMTM1(3,B),TCOEFF(B),TYPCUT(8)
      INTEGER ALTYR,BOUNO,DREAOY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      CDMMON/S/AVSOIL(11),DECLIN(11),NROADS,RATNRM(11),ROAOMI(11),
   1 ROADW(1I),TANCUT(11),TANFIL(11),TANRHO(11),YRCNST(11)
      INTEGER YRCNST
      COMMON/UTILTY/8LOCK(1B89),CHANGR,CHANGW,DATE(2),OATES(4),LINES,
   1 NAME,NDAY,RCHRGO,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAO(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(8LOCK(746),
   1 PPT(1)),(BLOCK(1118),RAO(1)),(8LOCK(1490),ETD(1)),(8LOCK(1B64),
   2 CDMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLO),(BLOCK(1B67),
   3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1B71),DCOMAX),(8LOCK(1B72),
   4 ISOTRM),(BLOCK(1B73),PEKOAT),(8LDCK(IB80),BIMNTH(1)),
   5 (BLOCK(1886),PEAKWE),(8LOCK(188B),PEAKRO)
      INTEGER PEKOAT,VEGTYP
      INTEGER YRALT
      YRALT = NEXTYR
C-----WATCH FOR RDAO CONSTRUCTION (SEOIMENT MOOELING)
      IF(IROADS(N).EO.1) GO TO 140
      NPLAN = NPLAN + 1
C-----IF THE RESPONSE UNIT NUMBER IS ZERO, THIS IS WEATHER MOOIFICATION
    1 IF(NUM) 2C,10
   10 SEEOYR(1) = NEXTYR
      SEEOYR(2) = PARAM(1)
      SEEOAT(1) = JWYDAT (INT(PARAM(2)/100.),INT(AMOD(PARAM(2),100.)))
      SEEOAT(2) = JWYDAT (INT(PARAM(3)/100.),INT(AMOO(PARAM(3),100.)))
      SEOINC = 1.0 + PARAM(4)
      GO TO 140
C-----IF THIS RESPONSE UNIT NUMBER IS ALREAOY IN THE TABLE, THIS CARD IS
C----- REOEFINING THE UNIT
   20 DO 3D I = 1,NUNIT
      N = I
      IF(RUNUM(N) - NUM) 30,BO
   30 CONTINUE
      N = NUNIT + 1
      IF(B - N) 40,50,50
   40 WRITE (6,910) NUM
  910 FORMAT(*OA MAXIMUM OF 7 ALTEREO RESPONSE UNITS IS ALLOWEO OUE TO I
     1NTERNAL PROGRAMMING REQUIREMENTS AND *I6,* WILL 8E NUMBER B - J08
     2A8ORTEO*)
      CALL ABORT
C-----START THIS RESPONSE UNIT OUT UNOER THE PRESENT CONDITIONS OF THE
C----- NATURAL RESPONSE UNIT
   50 NUNIT = N
      RUNUM(NUNIT) = NUM
      TCOEFF(NUNIT) = TCOEFF(1)
      COVOEN(NUNIT) = COVOEN(1)
      DECIOS(1,NUNIT) = DECIOS(1,1)
      DECIOS(2,NUNIT) = OECIOS(2,1)
      CALDEF(NUNIT) = CALDEF(1)
      OREAOY(NUNIT) = OREAOY(1)
      ENGBAL(NUNIT) = ENGBAL(1)
      FREWAT(NUNIT) = FREWAT(1)
      LASUSO(NUNIT) = LASUSO(1)
      NOYSNO(NUN1T) = NDYSNO(1)
      ONTRES(NUNIT) = ONTRES(1)
      PHASE(NUN1T) = PHASE(1)
      PREWEO(NUNIT) = PREWEO(1)
      RECHRG(NUNIT) = RECHRG(1)
      SIMTM1(1,NUNIT) = SIMTM1(1,1)
      SIMTM1(2,NUNIT) = SIMTM1(2,1)
      SIMTM1(3,NUNIT) = SIMTMI(3,1)
C-----OEFINE THE UNIT WEIGHT ANO REOEFINE THE NATURAL RESPONSE UNIT
C----- WEIGHT
      RUWT(NUNIT) = PARAM(1)
      RUWT(1) = 1.0
      OO 60 I = 2,NUNIT
   60 RUWT(1) = RUWT(1) - RUWT(I)
      IF(RUWT(I)) 70,75,75
   70 WRITE (6,920)
  920 FORMAT(*OTHE ALTEREO RESPONSE UNITS ACCOUNT FOR MORE THAN 100 PERC
     1ENT OF THE PLANNING UNIT - JOB A8ORTED*)
      CALL A8ORT
C-----IF THE NATURAL RESPONSE UNIT IS LESS THAN 1/2 OF ONE PERCENT, SET
C----- IT TO ZERO
   75 IF(RUWT(1).LT.0.005) RUWT(1) = 0.0
C-----OEFINE (OR REOEFINE) THE PARAMETERS FOR THE RESPONSE UNIT
   BO ALTYR(N) = NEXTYR
C-----IF THE COVER OENSITY WAS SPECIFIEO (PARAM(2) WAS FLAGGEO WITH A
C----- MINUS SIGN), GO OEFINE THE CORRESPONOING CUT
      IF(PARAM(2).LT.0.0) GO TO 160
      CUT(N) = PARAM(2)
C-----REOEFINE THE COVER DENSITY ANO TRANSMISSIVITY COEFFICIENT
      COVOEN(N) = COVOEN(N) * (1.0 - CUT(N))
   90 TCOEFF(N) = TC (COVOEN(N))
      IF(COVOEN(N).EO.0.0) ONTRES(N) = 0.0
      IF(VEGTYP.NE.3.ANO.VEGTYP.NE.4) GO TO 100
      OECIOS(2,N) = OECIOS(2,N) * (1.0 - CUT(N))
      OECIOS(1,N) = TC (OECIOS(2,N))
C-----OEFINE THE 8OUNOARIES FOR THE TIME TRENOS FUNCTIONS
  100 CALL GBOUNO (N)
C-----8ALANCE THE REOISTRIBUTION FACTORS
      CALL 8ALANC
C-----REAO THE NEXT MANAGEMENT PLAN CARO ANO IF IT IS FOR THE SAME YEAR,
C----- GO BACK TO OEFINE ANOTHER RESPONSE UNIT
  I40 CALL ROPLAN
      IF(YRALT - NEXTYR) I50,145
  145 IF(IROAOS(N) - 1) 1,140
C-----OETERMINE THE INITIAL EFFECTS (IF ANY) OF THE TIME TRENOS
  150 WRITE (17,940) PLUNIT,OATIME
  940 FORMAT(*1*6A10,52X2A10/115X*ALTEREO CONOITIONS*/*OCHANGES IN PARAM
     1ETERS OUE TO THE EFFECTS OF THE TIME TRENOS*/)
      CALL TRENDS
C-----AOO THIS INFORMATION TO THE STRATEGY LIST
      CALL SLIST (YRALT)
      RETURN
C-----USE THE SPECIFIEO COVER OENSITY ANO OEFINE THE CUT (REMEMBER,
C----- PARAM(2) IS NEGATIVE)
  160 CUT(N) = 1.0 + (PARAM(2)/COVOEN(N))
      IF(CUT(N)) 180,170,170
  170 COVOEN(N) = - PARAM(2)
      GO TO 90
  180 PARAM(2) = - PARAM(2)
      WRITE (6,950) COVOEN(N),PARAM(2)
  950 FORMAT(*OTHE CURRENT COVER OENSITY IS ONLY*F5.2,*, BUT THE MANAGEM
     1ENT PLAN IS REOUESTING A CUT*/*  WHICH WILL YIELO A SPECIFIED CDVE
     2R DENSITY OF*F5.2,* - JOB A8ORTEO*)
      CALL A8DRT
      END
```

Function IROADS

```
      FUNCTION IROADS (OUMMY)
C-----CHECK FOR ROAO CONSTRUCTION (SEDIMENT MOOELING).  SINCE THE
C----- SEOIMENT MOOEL IS TOTALLY INDEPENDENT, MERELY STORE THE
C----- PARAMETERS NOW FOR MOOELING AFTER THE MANAGEMENT PHASE IS
C----- COMPLETE
      COMMON/M/ALTYR(B),BOUNO(6,B),CALOEF(8),COVOEN(8),CUT(B),
     1 DECIDS(2,8),DREAOY(8),ENGBAL(B),EXPK(8),EXPK1(8),FREWAT(B),LAST1,
     2 LASUSO(B),LCOPY(14),NOYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(B),
     3 PARAM(9),PHASE(B),PHISQ(B),PREWEO(B),ROIST(8),ROMAX(8),RECHRG(B),
     4 REGROW(2,B),RUNUM(B),RUWT(8),SEOINC,SEEOAT(2),SEEOYR(2),
     5 SIMTM1(3,8),TCOEFF(B),TYPCUT(B)
      INTEGER ALTYR,BOUNO,OREADY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      COMMON/S/AVSOIL(11),OECLIN(11),NROAOS,RATNRM(11),ROAOMI(11),
     1 ROAOW(11),TANCUT(11),TANFIL(11),TANRHO(11),YRCNST(11)
      INTEGER YRCNST
      COMMDN/UTILTY/8LOCK(1889),CHANGR,CHANGW,OATE(2),OATES(4),LINES,
     1 NAME,NOAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER OATE,OATES,YEAR
      OIMENSION 8IMNTH(6),ETO(372),PPT(372),RAO(372),TMAX(372),TMIN(372)
      EOUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(8LOCK(746),
     1 PPT(1)),(8LOCK(1118),RAO(1)),(8LOCK(1490),ETO(1)),(BLOCK(1B64),
     2 COMAX),(8LOCK(1B65),VEGTYP),(8LOCK(1B66),TRSHLO),(8LOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(8LOCK(1B72),
     4 ISOTRM),(8LOCK(1873),PEKOAT),(8LOCK(18B0),8IMNTH(1)),
     5 (8LDCK(1BB6),PEAKWE),(BLOCK(1888),PEAKRG)
      INTEGER PEKDAT,VEGTYP
   10 1F(NAME.EQ.1DHROAD CONST) GO TO 20
      IROAOS = 0
      RETURN
   20 IF(NROADS - 11) 40,40,30
   30 WRITE (6,910) NEXTYR
  910 FORMAT(*OTHERE ARE MORE THAN 11 ROAO CONSTRUCTION CAROS INCLUOEO,
     1SO YEAR*I4,* WAS IGNOREO*)
      GO TD 50
C-----STORE THE PARAMETERS
   40 NRDAOS = NROAOS + 1
      YRCNST(NROADS) = NEXTYR
      ROAOMI(NROAOS) = PARAM(1)
      ROADW(NROAOS) = PARAM(2)
      RATNRM(NROAOS) = PARAM(3)
      AVSOIL(NROADS) = PARAM(4)
      DECLIN(NROAOS) = PARAM(5)
      TANCUT(NROAOS) = PARAM(6)
      TANFIL(NROAOS) = PARAM(7)
      TANRHO(NROADS) = PARAM(8)
   50 IROAOS = 1
      RETURN
      ENO
```

Subroutine NATURL

```
      SU8ROUTINE NATURL
C-----OEFINE THE NATURAL RESPONSE UN1T
      COMMON/M/ALTYR(B),8OUNO(6,8),CALDEF(8),COVOEN(8),CUT(8),
     1 OECIDS(2,8),OREAOY(8),ENG8AL(B),EXPK(8),EXPK1(B),FREWAT(8),LAST1,
     2 LASUSO(B),LCOPY(14),NOYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEQ(B),ROIST(B),ROMAX(8),RECHRG(B),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEOINC,SEEOAT(2),SEEOYR(2),
     5 SIMTM1(3,8),TCOEFF(B),TYPCUT(8)
      INTEGER ALTYR,BOUNO,OREAOY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      CDMMON/UTILTY/BLOCK(18B9),CHANGR,CHANGW,OATE(2),OATES(4),LINES,
     1 NAME,NOAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER OATE,OATES,YEAR
      OIMENSION BIMNTH(6),ETO(372),PPT(372),RAO(372),TMAX(372),TMIN(372)
      EQUIVALENCE (8LOCK(2),TMAX(1)),(8LOCK(374),TMIN(1)),(8LOCK(746),
     1 PPT(1)),(BLOCK(1118),RAO(1)),(8LOCK(1490),ETO(1)),(BLOCK(1B64),
     2 COMAX),(8LOCK(1865),VEGTYP),(8LOCK(1B66),TRSHLO),(8LOCK(1867),
     3 TMPMLT),(8LOCK(1B68),WILTPT),(BLOCK(1871),OCOMAX),(BLOCK(1872),
     4 ISOTRM),(8LOCK(1B73),PEKOAT),(8LOCK(1BB0),8IMNTH(1)),
     5 (8LOCK(18B6),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKOAT,VEGTYP
C-----THE NATURAL RESPONSE UNIT STARTS AS 100 PERCENT OF THE PLANNING
C----- UNIT ANO IS REOUCEO AS MANAGEMENT PLANS ARE INTROOUCEO
      RUWT(1) = 1.0
      ROIST(1) = 1.0
      RUNUM(1) = D
C-----OEFINE THE COVER OENSITY, TRANSMISSIVITY COEFFICIENT, ETC., FROM
C----- THE 8ASIC FILE
      TCOEFF(1) = 8LOCK(1862)
      COVOEN(1) = BLOCK(1863)
      OECIOS(1,1) = BLOCK(1B69)
      OECIOS(2,1) = 8LOCK(1B70)
      PREWEQ(1) = BLOCK(1B74)
      RECHRG(1) = 8LOCK(1B75)
      RCHRGO = RECHRG(1)
      WEO = PREWEO(1)
C-----SEE SUBROUTINE TRENOS FOR OEVELOPMENT OF THE EQUATION 8ELOW
      REGROW (2,1) = 1.0 - (0.5 * EXP (-I.609437912 * COVOEN(1)/COMAX))
      REGROW (1,1) = 0.5
      CALDEF(1) = 0.0
      OREAOY(1) = 0
      ENG8AL(1) = 0.0
      FREWAT(1) = 0.0
      LASUSO(1) = 0
      NOYSNO(1) = 0
      ONTRES(1) = 0.D
      PHASE(1) = 0
      SIMTM1(1,1) = 0.0
      SIMTM1(2,1) = 0.0
```

```
      SIMTM1(3,1) = -1.5
      TYPCUT(1) = 0
      NUNIT = 1
      RETURN
      END
```

Subroutine NORM

```
      SUBROUTINE NORM
C-----TRANSFER THE YEARLY RESULTS OF THE NORMAL SIMULATION TO THE
C----- PLANNING UNIT FILE
      COMMON DATIME(2),DECHAL,NRMANG,NSAVED,NYEARS,PLNDPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGDPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECOVR,REGION,REGDPT,SAVE,SEORN2
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      REWIND 11
      REWIND 12
      DO 30 I = 1,NYEARS
      CALL GETREC (11,BLOCK,1889,IEND)
      IF(IEND) 10,20
   10 J = I - 1
      WRITE (6,910) NYEARS,J
  910 FORMAT(*0THE REGION CARD SPECIFIES*I4,* YEARS, BUT THERE ARE ONLY*
     1 I4,* ON -DATFIL-.  JOB ABORTED*)
      CALL ABORT
C-----BLOCK(1116) = ACCUMULATED PRECIP ON 9/30
   20 WRITE (12,920) BLOCK(1),BLOCK(1876),BLOCK(1116),(BLOCK(K),K=1877,
     1 1889)
  920 FORMAT(* 0*16F6.2)
   30 CONTINUE
      RETURN
      END
```

Subroutine RDPLAN

```
      SUBROUTINE RDPLAN
C-----READ A MANAGEMENT PLAN CARD
      COMMON/M/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSD(8),LCOPY(14),NDYSND(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
C-----READ THE CARD
      READ (19) NAME,NUM,NEXTYR,PARAM,SPECCO
      IF(NAME.EQ.10HEND OF STR) 10,20
   10 NEXTYR = 9999
      RETURN
   20 LAST1 = NEXTYR
C-----IF A SPECIFIED COVER DENSITY IS INCLUDED, FLAG IT WITH A MINUS
      IF(SPECCO.NE.0.0) PARAM(2) = - SPECCO
      RETURN
      END
```

Subroutine SIM1YR

```
      SUBROUTINE SIM1YR
C-----SIMULATE ONE YEAR
      COMMON/M/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSD(8),LCOPY(14),NDYSND(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/TIME/CANREF,COMAX2,CONAV
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      COMMON/WTRBAL/ALLOW,ETFROM,EVAPTR,GENRO,PEAKED,PRECIP,RADIN,
     1 RADLWN,RADSWN,TMPMAX,TMPMIN,WATRIN
      YRTOT(1) = 0.0
      YRTOT(2) = 0.0
      YRTOT(3) = 0.0
      YEAR = BLOCK(1)
      DO 10 I = 1,NUNIT
   10 DREADY(I) = 0
C-----PERFORM THE SIMULATION
      PPTNOW = 0.0
      PEAKED = 0.0
      DO 90 NDAY = 1,372
      IF(TMAX(NDAY) + 1.E50) 30,90
C-----DEFINE THE DRIVING VARIABLES
   30 TMPMAX = TMAX(NDAY)
      TMPMIN = TMIN(NDAY)
      PPTNRM = PPT(NDAY) - PPTNOW
      PPTNOW = PPT(NDAY)
      RADIN = RAD(NDAY)
      WE(NDAY) = 0.0
      RO(NDAY) = 0.0
C-----DO NOT ALLOW INTERCEPTION IN JULY AND AUGUST
      ALLOW = 1.0
      IF(NDAY.GE.280.AND.NDAY.LE.341) ALLOW = 0.0
      IF(NDAY.EQ.PEKDAT) PEAKED = 1.0
C-----WATCH FOR DECIDUOUS FORESTS AND THEIR CHANGE OF SEASONS
      IF(VEGTYP.EQ.3.OR.VEGTYP.EQ.4) CALL DECDUS
C-----MAKE A PASS THROUGH THE WATER BALANCE ROUTINES FOR EACH RESPONSE
C----- UNIT
      DO 60 I = 1,NUNIT
      PRECIP = PPTNRM
      EVAPTR = ETO(NDAY)
C-----IF NECESSARY, ADJUST THE PRECIP
      IF(SEEDYR(1) - YEAR) 40,40,50
   40 IF(SEEDYR(2).LT.YEAR.OR.SEEDAT(1).GT.NDAY.OR.SEEDAT(2).LT.NDAY) GO
     1 TO 50
      PRECIP = PRECIP * SEDINC
   50 PRECIP = PRECIP * RDIST(I)
      CANREF = REGROW (2,I)
      CONAV = REGROW(1,I)
      CALL WATBAL (CALDEF(I),COMAX,COVDEN(I),DREADY(I),ENGBAL(I),
     1 FREWAT(I),LASUSD(I),NDYSND(I),ONTRES(I),PHASE(I),PREWEO(I),
     2 RECHRG(I),SIMTM1(1,I),SIMTM1(2,I),SIMTM1(3,I),TCOEFF(I),
     3 TMPMLT,TRSHLD,VEGTYP,WILTPT)
C-----STORE THESE RESULTS
      WE(NDAY) = WE(NDAY) + (PREWEO(I) * RUWT(I))
      RO(NDAY) = RO(NDAY) + (GENRO * RUWT(I))
      YRTOT(2) = YRTOT(2) + (PRECIP * RUWT(I))
      YRTOT(3) = YRTOT(3) + (EVAPTR * RUWT(I))
   60 CONTINUE
      YRTOT(1) = YRTOT(1) + RO(NDAY)
C-----WATCH FOR THE MANDATORY ISOTHERMAL DATE
      IF(ISOTRM - NDAY) 90,70
   70 DO 80 I = 1,NUNIT
      DREADY(I) = -1
   80 CALDEF(I) = 0.0
   90 CONTINUE
      RETURN
      END
```

Subroutine SLIST

```
      SUBROUTINE SLIST (YRALT)
C-----LIST THE MANAGEMENT STRATEGY
      COMMON/M/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSD(8),LCOPY(14),NDYSND(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      COMMON/S/AVSOIL(11),DECLIN(11),NROADS,RATNRM(11),ROADMI(11),
     1 ROADW(11),TANCUT(11),TANFIL(11),TANRHD(11),YRCNST(11)
      INTEGER YRCNST
      COMMON/UTILTY/BLOCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLOCK(1872),
     4 ISOTRM),(BLOCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLOCK(1886),PEAKWE),(BLOCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      INTEGER YRALT
      IPRINT = 0
C-----CHECK FOR CLOUD SEEDING
      IF(YRALT - SEEDYR(1)) 20,10
   10 CALL GDATE (SEEDAT(1),DATES(1))
      CALL GDATE (SEEDAT(2),DATES(3))
      WRITE (18,910) SEEDYR,SEDINC,DATES
  910 FORMAT(*0IN YEAR*I4,* AND THROUGH YEAR*I4,*, CLOUD SEEDING MULTIPL
     1IES PPT BY*F5.2,* BETWEEN*I3,*/*I2,* AND*I3,*/*I2,*.*)
      IPRINT = 1
C-----CHECK THE YEAR OF THE MANAGED RESPONSE UNITS
   20 IF(NUNIT - 2) 80,30,30
   30 DO 70 I = 1,NUNIT
      IF(YRALT - ALTYR(I)) 70,40
   40 IPRCNT = (CUT(I) * 100.) + 0.5
      IF(IPRINT) 50,60
   50 WRITE (18,920) RUNUM(I),RUWT(I),IPRCNT
  920 FORMAT(13X*ON RESPONSE UNIT*I6,* (AREA WEIGHT =*F5.2,*),*I4,* PERC
     1ENT OF THE CURRENT COVER DENSITY WAS REMOVED.*)
      GO TO 70
   60 WRITE (18,930) YRALT,RUNUM(I),RUWT(I),IPRCNT
  930 FORMAT(*0IN YEAR*I4,* ON RESPONSE UNIT*I6,* (AREA WEIGHT =*F5.2,*)
     1,*I4,* PERCENT OF THE CURRENT COVER DENSITY WAS REMOVED.*)
      IPRINT = 1
   70 CONTINUE
C-----CHECK FOR ROAD CONSTRUCTION
   80 IF(NROADS) 90,150
   90 DO 140 I = 1,NROADS
      IF(YRALT - YRCNST(I)) 140,100
  100 IPRCNT = (TANRHD(I) * 100.) + 0.5
      IF(IPRINT) 120,110
  110 WRITE (18,940) YRALT,ROADMI(I),ROADW(I),IPRCNT
  940 FORMAT(*0IN YEAR*I4,* ROAD CONSTRUCTION CREATED*F6.1,* MILES OF RO
     1AD AVERAGING*F5.1,* FEET WIDE THROUGH AN AVERAGE SIDESLOPE OF*I3,
     2 * PERCENT.*)
      IPRINT = 1
```

```
      GO TO 130
  120 WRITE (18,950) ROADMI(I),ROAOW(I),IPRCNT
  950 FORMAT(13X*ROAO CONSTRUCTION CREATEO*F6.1,* MILES OF ROAO AVERAGIN
     1G*F5.1,* FEET WIOE THROUGH AN AVERAGE SLOPE OF*I3,* PERCENT.*)
  130 IPRCNT = (TANCUT(I) * 100.) + 0.5
      JPRCNT = (TANFIL(I) * 100.) + 0.5
      WRITE (18,960) IPRCNT,JPRCNT,RATNRM(I),AVSOIL(I),OECLIN(I)
  960 FORMAT(14X*THE SLOPES OF CUT ANO FILL AVERAGEO*I3,* ANO*I3,* PERCE
     1NT, RESPECTIVELY.  THE ESTIMATE OF THE LONG-TERM NORMAL*/14X*EROSI
     2ON RATE WAS*F7.2,*, THE INOEX OF THE AMOUNT OF SOIL AVAILABLE FOR
     3EROSION WAS*F7.2,*, ANO THE INOEX OF THE*/14X*RATE OF OECLINE OF E
     4ROSION FOLLOWING OISTURBANCE WAS*F7.2,*.*)
  140 CONTINUE
  150 RETURN
      ENO
```

Subroutine TITLEM

```
      SUBROUTINE TITLEM
C-----PRINT THE TITLE SHEET
      COMMON OATIME(2),OECMAL,NRMANG,NSAVEO,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER OATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEORN2
      COMMON/M/ALTYR(8),BOUNO(6,8),CALDEF(8),COVOEN(8),CUT(8),
     1 OECIOSI2,8),OREAOY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8I,LAST1,
     2 LASUSO(8),LCOPY(14),NOYSNOI8),NEXTYR,NPLAN,NUM,NUNIT,ONTRESI8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),ROISTI8),ROMAX(8),RECHRG(8I,
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEOINC,SEEOAT(2),SEEOYRI2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUTI8)
      INTEGER ALTYR,8OUNO,OREAOY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      COMMON/TIME/CANREF,COMAX2,CONAV
      COMMON/UTILTY/8LOCK(1889),CHANGR,CHANGW,OATE(2),OATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOTI3)
      INTEGER OATE,OATES,YEAR
      OIMENSION 8IMNTH(6),ETO(372),PPT(372),RAOI372),TMAX(372),TMIN(372)
      EOUIVALENCE (8LOCK(2),TMAXI1)),I8LOCK(374),TMIN(II),(8LOCK(746),
     1 PPT(1)),(BLOCK(1118),RAD(1)),(8LOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLOCK(1865),VEGTYP),(BLOCK(1866),TRSHLO),(BLOCKI1867),
     3 TMPMLT),(BLOCK(1868),WILTPT),I8LOCK(1871),OCOMAX),(8LOCK(I872),
     4 ISOTRM),(BLOCK(1873),PEKOAT),(BLOCK(1880),BIMNTHI1)),
     5 IBLOCK(1886),PEAKWE),(BLOCKI1888),PEAKRO)
      INTEGER PEKOAT,VEGTYP
      WRITE I6,910) PLUNIT,OATIME
  910 FORMAT(*1*6A10,52X2AI0/115X*ALTEREO CONOITIONS*)
      RUNUM(1) = 10H   NATURAL
      WRITE (6,920) (RUNUM(I),I=1,NUNIT)
  920 FORMAT(*ORESPONSE UNIT NUM8ER*10XA10,7I10)
      RUNUM(1) = 0
      WRITE (6,921) (RUWT(I),I=1,NUNITI
  92I FORMAT(*OPERCENT OF PLAN UNIT*10X8FI0.2)
      IF(NUNIT - 2) 20,10,10
   10 WRITE I6,922) (ALTYR(I),I=2,NUNIT)
  922 FORMAT(* YEAR OF CUT          *20X7I10)
      WRITE (6,923) ICUT(I),I=2,NUNIT)
  923 FORMAT(* PERCENT OF CUT       *20X7FI0.2)
      WRITE (6,924I (ROIST(I),I=1,NUNIT)
  924 FORMAT(* PRECIP REOIST FACTOR*10X8F10.2)
      WRITE I6,925) (BOUNO(5,I),I=2,NUNIT)
  925 FORMAT(*   CHANGE STARTS IN  *20X7I10)
      WRITE (6,926) (8OUND(6,I),I=2,NUNIT)
  926 FORMAT(*   CHANGE ENOS IN    *20X7I10)
      WRITE I6,927) (REGROW(I,I),I=2,NUNIT)
  927 FORMATI* REGROWTH-AVAIL WATER*20X7FI0.2)
      WRITE (6,925) (8OUNO(1,I),I=2,NUNIT)
      WRITE (6,926) (BOUNO(2,II,I=2,NUNIT)
      WRITE (6,928) (REGROW(2,I),I=2,NUNIT)
  928 FORMAT(* REGROWTH-REFLECTIVTY*20X7F10.2)
      WRITE (6,925) (BOUNO(3,I),I=2,NUNIT)
      WRITE (6,926) (8OUNO(4,I),I=2,NUNIT)
   20 WRITE (6,930) (TCOEFF(I),I=1,NUNIT)
  930 FORMAT(* TRANSMISSIVITY COEFF*10X8FI0.2)
      WRITE (6,931) (COVOEN(I),I=1,NUNIT)
  931 FORMAT(* COVER OENSITY        *10X8FI0.2)
      TMPMLF = (TMPMLT * 1.8) + 32.
      WRITE (6,932) COMAX,VEGTYP,TRSHLO,TMPMLF,WILTPT
  932 FORMAT(* MAXIMUM COVER OEN    *IOXFI0.2/
     1 * VEGETATION TYPE      *10XI10  /* REFLECTIVITY THRSHLO*10XFI0.2/
     2 * MELT THRESHOLO       *10XFI0.2/* WILTING POINT        *IOXFI0.2)
      IF(VEGTYP.NE.3) GO TO 30
      WRITE (6,940) (OECIOS(1,I),I=1,NUNITI
  940 FORMAT(* OECIOUOUS WINTER TC *10X8F10.2)
      WRITE I6,941) IOECIOSI2,I),I=1,NUNIT)
  941 FORMAT(* OECIOUOUS WINTER CO *10X8F10.2)
      WRITE (6,942) OCOMAX
  942 FORMAT(* DECIDUOUS WNTR COMAX*10XFI0.2)
   30 WRITE (6,950) (SIMTM1(2,I),I=1,NUNIT)
  950 FORMATI*OINITIAL CONDITIONS*/* AVERAGE PACK TEMP.  *10X8FI0.2)
      WRITE (6,951) (PREWEQ(I),I=1,NUNIT)
  951 FORMAT(* PACK WATER EQUIV.   *10X8F10.2)
      WRITE I6,952) (RECHRG(I),I=1,NUNIT)
  952 FORMAT(* RECHARGE REQUIREMENT*10X8F10.2)
      IF(SEEOYR(1) - 9999) 40,50
   40 CALL GOATE (SEEOAT(1),OATESI1))
      CALL GOATE (SEEOAT(2),OATES(3))
      WRITE I6,960) SEEOYR,OATES,SEOINC
  960 FORMAT(*OCLOUO SEEOING FROM *I4,* TO *I4,*, OAYS *I2,*/*I2,* TO *
     1 I2,*/*I2,*, WITH A FACTOR OF *F6.2)
   50 RETURN
      ENO
```

Subroutine BALANC

```
      SUBROUTINE BALANC
C-----BALANCE THE REDISTRIBUTION FACTORS
      CGMMON/M/ALTYR(8),BOUND(6,8),CALOEFI8),COVOENI8),CUT(R),
     1 DECIOS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1I8),FREWATI8),LAST1,
     2 LASUSD(8),LCOPY(14),NOYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISQ(8),PREWEO(8),ROISTI8I,ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEOINC,SEEOAT(2),SEEOYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUNO,OREAOY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      IF(NUNIT - 2) 10,20,20
   10 RETURN
C-----ACCUMULATE THE WEIGHTS FOR THE AREAS ON WHICH THERE IS
C----- REDISTRIBUTION WHILE CALCULATING THE REMAINING RORTION FOR THE
C----- OTHER AREAS
   20 ROSTWT = 0.0
      REMAIN = 1.0
      OO 40 N = 2,NUNIT
      IF(TYPCUT(N)) 30,40
   30 ROSTWT = RDSTWT + RUWT(N)
      REMAIN = REMAIN - (ROIST(N) * RUWT(NI)
   40 CONTINUE
      IF(ABS(REMAIN).LT.0.0I) REMAIN = 0.0
      IFIREMAIN) 50,60,60
   50 WRITE (6,910I
  910 FORMAT(*1THE REOISTRIBUTION OF THE PRECIP TOTALS MORE THAN 100 PER
     1CENT - JOB ABORTEO*)
      CALL ABORT
C-----CALCULATE THE CORRESPONOING EFFECT ON PRECIP FOR THE NATURAL UNIT
C----- ANO THOSE WHERE REDISTRIBUTION WAS NOT SPECIFIEO
   60 REST = 1.0 - ROSTWT
      IF(REST) 70,70,80
   70 EFFECT = 0.0
      GO TO 90
   80 EFFECT = REMAIN/REST
C-----OEFINE THE REOISTRIBUTION FACTORS FOR THOSE AREAS
   90 OO 110 N = I,NUNIT
      IF(TYPCUT(N)) 110,100
  100 ROIST(N) = EFFECT
  110 CONTINUE
      RETURN
      ENO
```

Subroutine GBOUND

```
      SUBROUTINE G8OUNO (N)
C-----GET THE 8OUNOARY YEARS - IIF NOT SPECIFIEO, USE THE ASSUMEO
C----- VALUES)
      COMMON/M/ALTYR(8),8OUNO(6,8),CALOEF(8),COVOEN(8),CUT(8),
     1 OECIOS(2,8),OREAOY(8),ENG8AL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSO(8),LCOPY(14),NOYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISQ(8),PREWEQ(8),ROISTI8),ROMAX(8),RECHRG(8),
     4 REGROW(2,8),RUNUM(8),RUWT(8),SEOINC,SEEOAT(2),SEEOYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,8OUNO,OREAOY,PHASE,RUNUM,SEEOAT,SEEOYR,TYPCUT
      COMMON/TIME/CANREF,COMAX2,CONAV
      COMMON/UTILTY/8LOCK(I889I,CHANGR,CHANGW,OATE(2),OATES(4),LINES,
     I NAME,NOAY,RCHRGO,RO(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER OATE,OATES,YEAR
      OIMENSION BIMNTH(6),ETO(372),PPT(372),RAOI372),TMAX(372),TMIN(372I
      EOUIVALENCE (8LOCK(2),TMAX(1)),(8LOCK(374),TMIN(I)),(8LOCK(746),
     I PPT(I)),(8LOCK(1118),RAO(1)),(8LOCK(I490),ETO(1)),(8LOCK(1864),
     2 COMAX),(BLOCK(I865),VEGTYP),(8LOCK(I866),TRSHLO),(BLOCKI1867),
     3 TMPMLT),(BLOCK(I868),WILTPT),(8LOCK(I871),OCOMAX),(8LOCK(1872),
     4 ISOTRM),I8LOCK(1873),PEKOAT),(BLOCK(I880),8IMNTH(1)),
     5 (8LOCK(1886),PEAKWE),(8LOCK(1888),PEAKRO)
      INTEGER PEKOAT,VEGTYP
      INTEGER YRPAST
      OIMENSION ASSUMO(7,3)
C-----LOOGEPOLE PINE
      OATA ASSUMOI1,1),ASSUMO(2,I),ASSUMO(3,1),ASSUMO(4,1),ASSUMO(5,1),
     1 ASSUMO(6,I),ASSUMO(7,1I/I5.,80.,0.,40.,40.,120.,0.0/
C-----SPRUCE-FIR
      OATA ASSUMO(1,2),ASSUMOI2,2),ASSUMO(3,2),ASSUMO(4,2),ASSUMO(5,2),
     1 ASSUMO(6,2),ASSUMO(7,2)/30.,100.,0.,80.,80.,I60.,0.0/
C-----ASPEN
      OATA ASSUMO(1,3),ASSUMO(2,3I,ASSUMO(3,3),ASSUMO(4,3),ASSUMO(5,3),
     1 ASSUMO(6,3),ASSUMO(7,3)/7.,60.,0.,20.,20.,80.,0.0/
      COMAX2 = COMAX/2.0
C-----IF THE CUT IS LESS THAN 50 PERCENT, IT IS ASSUMEO THAT THE
C----- PATCH CUT TRANSITION LEVEL OF THE FOREST IS ZERO
      IF(COMAX2 - COVOEN(N)) 10,10,20
   10 8OUNOII,N) = ALTYR(NI - 1
      BOUNO(2,N) = 8OUNO(1,N)
      BOUNOI3,N) = BOUNO(I,N)
      8OUND(4,N) = BOUND(1,N)
      BOUNO(5,N) = 8OUNO(I,N)
      BOUNO(6,N) = 8OUNO(I,N)
      ROMAXIN) = 0.0
      ROIST(N) = I.0
      TYPCUT(N) = 0
      RETURN
C-----USE THE ASSUMEO VALUES IF ALL PARAMETERS ARE BLANK
   20 OO 40 I = I,6
      IF(PARAM(I+2)) 50,30
   30 8OUND(I,N) = ASSUMO(I,VEGTYP)
   40 CONTINUE
      ROMAX(N) = ASSUMO(7,VEGTYP)
      GO TO 70
C-----SINCE AT LEAST ONE OF THE PARAMETERS WAS SPECIFIEO, USE THEM ALL
   50 OO 60 I = 1,6
      BOUNO(I,N) = PARAM(I+2)
C-----CERTIFY THAT THE ENOING YEARS FOLLOW THE 8EGINNING YEARS
      IFII.EO.1.OR.I.EQ.3.OR.I.EO.5) GO TO 60
      IF(BOUND(I-I,N).LT.BOUNO(I,N)) GO TO 60
      WRITE (6,910) ALTYR(N),RUNUMIN),8OUNO(I,N),8OUNO(I-I,N)
  910 FORMAT(*OMANAGEMENT PLAN CARO ERROR - YEAR*I4,*, RESPONSE UNIT*I6,
     1 *, ENOING YEAR*I4,* OOES NOT FOLLOW BEGINNING YEAR*I4,* - JOB A8O
     2RTEO*)
      CALL ABORT
   60 CONTINUE
      ROMAX(N) = PARAM(9)
C-----OEFINE PHI SQUARED FOR THE REFLECTIVITY ANO COVER OENSITY FUNCTION
   70 PHISQIN) = (8OUNO(4,N) - BOUNOI3,N)) ** 2
C-----IF THIS IS A THINNING CUT RATHER THAN A PATCH CUT, AOJUST THE
C----- BOUNOARIES TO COMPENSATE (THIS ALLOWS THE REMOVAL OF THE
C----- OVERSTORY, BUT LEAVES A STANO WHICH, IN TERMS OF THE SIMULATION
C----- FUNCTIONS, IS ALREAOY IN THE PROCESS OF REGROWTH)
      IF(COVOEN(N)) 100,100,80
   80 YRPAST = SQRT ((COVDEN(N) * PHISQ(N))/COMAX) + 0.5
      DO 90 I = 1,6
   90 8OUND(I,N) = BOUND(I,N) - YRPAST
```

```
C-----DEFINE THE 8DUNDAPIES IN TERMS OF THE YEAR OF TREATMENT
  100 DD 110 I = 1,6
  110 BOUND(I,N) = 8DUND(I,N) + ALTYR(N)
C-----CDMPUTE THE K FDR THE INVERSE EXPDNENTIAL FUNCTION REPRESENTING
C----- THE AVAILABLE SDIL WATER FACTDR
C-----GIVEN THAT TAU = M*EXP(-K*(T-TC)), AT TIME T = FULL REGROWTH, TAU
C----- BECOMES M/2.  THUS,
C----- M/2 = M*EXP(-K*(T-TC)), WHICH YIELDS
C----- 1/2 = EXP(-K*(T-TC)).  UPDN TAKING THE NATURAL LDG,
C----- LN(.5) = -K*(T-TC), DR
C----- K = -LN(.5)/(T - TC)
      EXPK(N) = 0.6931471805/FLDAT(8DUND(2,N) - 8DUND(1,N))
C-----COMPUTE THE K FDR THE INVERSE EXPDNENTIAL FUNCTIDN REPRESENTING
C----- THE PRECIP REDISTRIBUTION
C-----GIVEN THAT RHO = RHD(MAX) * EXP (-K1*(T-TC)), AT TIME T = FULL
C----- REGROWTH, RHD MUST APPRDACH ZERD (ASSUME 1 PERCENT).  HENCE,
C----- .01 = RHD(MAX) * EXP (-K1*(T-TC)), DR
C----- .01/RHO(MAX) = EXP(-K1*(T-TC)).  UPDN TAKING THE NATURAL LOG,
C----- LN(.01/RHO(MAX)) = -K1*(T-TC), OR
C----- K1 = -LN(.01/RHD(MAX))/(T-TC)  (WATCH FDR RHD(MAX) = 0)
      IF(RDMAX(N)) 130,120,130
  120 8DUND(5,N) = ALTYR(N) - 1
      BOUND(6,N) = ALTYR(N) - 1
      RETURN
  130 EXPK1(N) = - ALDG(0.01/ABS(RDMAX(N)))/FLDAT(8DUND(6,N)-8DUND(5,N))
      TYPCUT(N) = 1
      RETURN
      END
```

Subroutine TRENDS

```
      SUBRDUTINE TRENDS
C-----DETERMINE THE EFFECTS DF THE TIME TREND(S)
      CDMMDN/H/ALTYR(8),BOUND(6,8),CALDEF(8),COVDEN(8),CUT(8),
     1 DECIDS(2,8),DREADY(8),ENGBAL(8),EXPK(8),EXPK1(8),FREWAT(8),LAST1,
     2 LASUSD(8),LCOPY(14),NDYSNO(8),NEXTYR,NPLAN,NUM,NUNIT,ONTRES(8),
     3 PARAM(9),PHASE(8),PHISO(8),PREWEO(8),RDIST(8),RDMAX(8),RECHRG(8),
     4 REGRDW(2,8),RUNUM(8),RUWT(8),SEDINC,SEEDAT(2),SEEDYR(2),
     5 SIMTM1(3,8),TCOEFF(8),TYPCUT(8)
      INTEGER ALTYR,BOUND,DREADY,PHASE,RUNUM,SEEDAT,SEEDYR,TYPCUT
      CDMMDN/TIME/CANREF,CDMAX2,CDNAV
      CDMMDN/UTILTY/BLDCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSIDN BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLDCK(2),TMAX(1)),(BLOCK(374),TMIN(1)),(BLOCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLOCK(1490),ETO(1)),(BLOCK(1864),
     2 COMAX),(BLDCK(1865),VEGTYP),(BLOCK(1866),TRSHLD),(BLOCK(1867),
     3 TMPMLT),(BLDCK(1868),WILTPT),(BLOCK(1871),DCOMAX),(BLDCK(1872),
     4 ISDTRM),(BLDCK(1873),PEKDAT),(BLOCK(1880),BIMNTH(1)),
     5 (BLDCK(1886),PEAKWE),(BLOCK(1888),PEAKRO)
      INTEGER PEKDAT,VEGTYP
      IF(NUNIT - 2) 10,20,20
   10 RETURN
   20 DD 170 N = 2,NUNIT
C-----AVAILABLE SOIL WATER ADJUSTMENT (ACCOUNTS FOR INCREASED CANDPY
C----- DENSITY AND RODTING DEPTH)
C-----REGRDW(1,N) WILL BE -CDNAV-
      IF(YEAR - 8DUND(1,N)) 30,30,40
C-----THE CUT AREA IS STILL TO BE CONSIDERED  AS AN OPENING
   30 REGRDW(1,N) = 1.0
      GO TD 70
   40 IF(8DUND(2,N) - YEAR) 50,50,60
C-----REGRDWTH IS CDMPLETE AS FAR AS THIS FACTOR IS CDNCERNED
   50 REGRDW(1,N) = 0.5
      GD TD 70
C-----REGRDWTH HAS OCCURRED, BUT IS NDT COMPLETE
   60 REGRDW(1,N) = EXP (-EXPK(N) * (FLOAT(YEAR - BOUND(1,N))))
      WRITE (17,910) YEAR,RUNUM(N),REGRDW(1,N)
  910 FORMAT(* AFTER THE GRDWING SEASON OF WATER YEAR*I4,* DN RESPDNSE U
     1NIT*I6,*, THE AVAILABLE WATER FACTOR IS*F5.2)
C-----CANDPY REFLECTIVITY ADJUSTMENT AND COVER DENSITY
C-----REGRDW(2,N) WILL BE -CANREF-
   70 IF(BOUND(4,N) - YEAR) 80,90,90
C-----REGRDWTH IS CDMPLETE AS FAR AS THE CANOPY REFLECTIVITY IS
C----- CONCERNED
   80 REGRDW(2,N) = 1.0 - (0.5 * EXP(-1.609437912 * CDVDEN(N)/COMAX))
      GO TO 120
C-----REGRDWTH HAS OCCURRED, BUT IS NDT COMPLETE
C-----GIVEN THAT RF = RFO * EXP (-DMEGA*COMAX*T**2/PHI**2), AT TIME T =
C----- PHI,  RF = RFO * EXP (-OMEGA*CDMAX).  AT TIME PHI, THE MAXIMUM
C----- COVER DENSITY HAVE BEEN REACHED.  HENCE, RF = 0.1 (RFO IS A
C----- CDNSTANT 0.5), WHICH YIELDS
C----- 0.1 = 0.5 * EXP (-DMEGA * COMAX), OR
C----- 0.2 = EXP (-DMEGA*CDMAX).  UPON TAKING THE NATURAL LOG,
C----- LN(0.2) = -OMEGA * COMAX, WHICH YIELDS
C----- DMEGA = - LN(0.2)/CDMAX.  SUBSTITUTIDN PRODUCES
C----- RF = 0.5*EXP (-1.609*T**2/PHI**2).
C----- THE VARIABLE -CANREF- IS DEFINED TO BE 1 - RF
   90 IF(YEAR - BDUND(3,N)) 100,100,110
C-----THE CUT AREA IS STILL AN DPENING
  100 REGRDW(2,N) = 0.5
      GD TD 120
  110 TBYPHI = (FLDAT(YEAR - BDUND(3,N))**2)/PHISO(N)
      REGROW(2,N) = 1.0 - (0.5 * EXP (-1.609437912 * TBYPHI))
      COVDEN(N) = CDMAX * TBYPHI
      TCOEFF(N) = TC (CDVDEN(N))
      WRITE (17,920) YEAR,RUNUM(N),REGRDW(2,N),COVDEN(N)
  920 FDRMAT(* AFTER THE GRDWING SEASON DF WATER YEAR*I4,* DN RESPDNSE U
     1NIT*I6,*, THE CANDPY REFLECTIVITY FACTDR IS*F5.2,*, CDVER DENSITY
     2IS*F5.2)
      IF(VEGTYP.NE.3.AND.VEGTYP.NE.4) GD TD 120
      DECIDS(2,N) = DCDMAX * TBYPHI
      DECIDS(1,N) = TC (DECIDS(2,N))
      WRITE (17,930) DECIDS(2,N)
  930 FDRMAT(*  WITH A WINTER CDVER DENSITY OF*F5.2)
C-----REDISTRIBUTIDN
  120 IF(YEAR - BOUND(5,N)) 130,140,140
C-----MAXIMIZE REDISTRIBUTIDN
  130 RDIST(N) = 1.0 + RDMAX(N)
      GD TO 170
  140 IF(BOUND(6,N) - YEAR) 150,150,160
C-----REGROWTH IS CDMPLETE
  150 RDIST(N) = 1.0
      TYPCUT(N) = 0
      GD TO 170
C-----ADJUST THE REDISTRIBUTIDN
  160 RDIST(N) = 1.0 + (RDMAX(N) * EXP(-EXPK1(N) * FLOAT(YEAR-8DUND(5,N)
     1)))
      WRITE (17,940) YEAR,RUNUM(N),RDIST(N)
  940 FORMAT(* AFTER THE GRDWING SEASDN DF WATER YEAR*I4,* ON RESPDNSE U
     1NIT*I6,*, THE PRECIP REDISTRIBUTIDN FACTDR IS*F5.2)
  170 CONTINUE
C-----BALANCE THE REDISTRIBUTION FACTDRS
      CALL BALANC
      RETURN
      END
```

Program SEDMOD

```
      DVERLAY (DLAYS,2,3)
      PRDGRAM SEDMDD
C-----SEDIMENT YIELD MDDEL
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNDPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGDPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECDVR,REGION,REGDPT,SAVE,SEDRN2
      COMMON/S/AVSDIL(11),DECLIN(11),NRDADS,RATNRM(11),RDADMI(11),
     1 RDADW(11),TANCUT(11),TANFIL(11),TANRHD(11),YRCNST(11)
      INTEGER YRCNST
      CDMMON/UTILTY/BLDCK(1889),CHANGR,CHANGW,DATE(2),DATES(4),LINES,
     1 NAME,NDAY,RCHRGO,RD(372),WE(372),WEO,YEAR,YRTOT(3)
      INTEGER DATE,DATES,YEAR
      DIMENSION BIMNTH(6),ETO(372),PPT(372),RAD(372),TMAX(372),TMIN(372)
      EQUIVALENCE (BLOCK(2),TMAX(1)),(BLDCK(374),TMIN(1)),(BLDCK(746),
     1 PPT(1)),(BLDCK(1118),RAD(1)),(BLDCK(1490),ETO(1)),(BLDCK(1864),
     2 COMAX),(BLDCK(1865),VEGTYP),(BLDCK(1866),TRSHLD),(BLDCK(1867),
     3 TMPMLT),(BLDCK(1868),WILTPT),(BLDCK(1871),DCOMAX),(BLOCK(1872),
     4 ISDTRM),(BLDCK(1873),PEKDAT),(BLDCK(1880),BIMNTH(1)),
     5 (BLDCK(1886),PEAKWE),(BLDCK(1888),PEAKRD)
      INTEGER PEKDAT,VEGTYP
      DIMENSIDN LCDPY(14),NCDL(165),DNELIN(11),SEDNAT(165,11),
     1 SEDINC(165,11)
      INTEGER CDDE(11),PDINT(121),YEARS(165)
C-----EQUIVALENCE ARRAYS TD SAVE STDRAGE REQUIREMENTS
      EQUIVALENCE (BLDCK,SEDNAT),(RD,NCDL),(WE,YEARS)
      DATA CDDE/1H1,1H2,1H3,1H4,1H5,1H6,1H7,1H8,1H9,1HA,1HB/
C-----CDPY THE DESCRIPTIDN OF THE STRATEGY
      REWIND 18
      GD TO 3
    1 WRITE (6,903) LCDPY
  903 FDRMAT(13A10,A6)
    3 READ (18,903) LCOPY
      IF(EOF(18)) 5,1
    5 REWIND 18
      END FILE 18
      REWIND 12
C-----DEFINE THE CDLUMN CDUNTER AND THE YEARS
      DO 10 I = 1,NYEARS
      NCDL(I) = 0
   10 READ (12,906) YEARS(I)
  906 FORMAT(2XI3)
C-----CALCULATE THE ACCUMULATED SEDIMENT FDR THE DISTURBED AREA AS
C----- THDUGH IT REMAINED IN ITS NATURAL STATE, THEN CALCULATE THE
C----- INCREASE
      DO 50 I = 1,NROADS
      CDNST = (RDADW(I)/2.0) * TANRHD(I)
      DISTRB = 0.121 * RDADMI(I) * (ROADW(I) +
     1 (CONST/(TANFIL(I) - TANRHD(I))) +
     2 (CDNST/(TANCUT(I) - TANRHD(I))))
C-----PLACE THIS YEAR IN THE TABLE
      DD 20 J = 1,NYEARS
      K = J
      IF(YRCNST(I) - YEARS(J)) 20,30
   20 CONTINUE
C-----CALCULATE THE VALUES FDR THE FIRST YEAR, THEN THE REMAINING YEARS
   30 SEDNAT(K,I) = DISTRB * RATNRM(I)
      CDNST = DISTRB * AVSOIL(I)
      SEDINC(K,I) = CDNST * (1.0 - EXP(-DECLIN(I)))
      NCDL(K) = I
      L = K + 1
      IF(L.GT.NYEARS) GD TO 45
      DECTIM = DECLIN(I)
      RATTIM = SEDNAT(K,I)
      DD 40 J = L,NYEARS
      SEDNAT(J,I) = SEDNAT(J-1,I) + RATTIM
      DECTIM = DECTIM + DECLIN(I)
      SEDINC(J,I) = CONST * (1.0 - EXP(-DECTIM))
      NCOL(J) = I
   40 CONTINUE
   45 IF(I.EQ.1) GD TD 50
      L = I - 1
      DD 46 J = K,NYEARS
      SEDNAT(J,I) = SEDNAT(J,I) + SEDNAT(J,L)
   46 SEDINC(J,I) = SEDINC(J,I) + SEDINC(J,L)
   50 CDNTINUE
   60 IPASS = 1
      NAMSED = 10HCUMULATIVE
C-----PRINT THE COMBINED AMOUNTS, THEN THE INCREASE DVER NATURAL
C----- CDNDITIONS
   70 DD 120 I = 1,NYEARS,55
      WRITE (6,910) PLUNIT,DATIME,NAMSED
  910 FDRMAT(*1*6A10,52X2A10/113XA10,* SED YIELD*/*0*/* YEAR*/)
      N1 = I
      N2 = I + 54
      IF(N2.GT.NYEARS) N2 = NYEARS
      DO 110 N = N1,N2
      IF(NCOL(N)) 90,80
   80 WRITE (6,920) YEARS(N)
  920 FDRMAT(1XI5,15X11F10.0)
      GO TO 110
   90 JI = NCOL(N)
      DO 100 J = 1,JI
  100 DNELIN(J) = SEDNAT(N,J) + SEDINC(N,J)
      WRITE (6,920) YEARS(N),(DNELIN(J),J=1,JI)
  110 CDNTINUE
  120 CONTINUE
```

```
C-----PRINT THE INCREASE OVER NATURAL CONDITIONS
      DO 160 I = 1,NYEARS,55
      WRITE (6,930) PLUNIT,DATIME,NAMSED
  930 FORMAT(*1*6A10,52X2A10/* EFFECTS OF TREATMENT COMPARED WITH NATURA
     1L CONDITIONS (DECREASE INDICATED BY -)*33XA10,* SED YIELD*/*0*/
     2 * YEAR*/)
      N1 = I
      N2 = I + 54
      IF(N2.GT.NYEARS) N2 = NYEARS
      DO 150 N = N1,N2
      IF(NCOL(N)) 140,130
  130 WRITE (6,920) YEARS(N)
      GO TO 150
  140 J1 = NCOL(N)
      WRITE (6,920) YEARS(N),(SEDINC(N,J),J=1,J1)
  150 CONTINUE
  160 CONTINUE
C-----IF THE ANNUAL TOTALS HAVE PRINTED, GO ON TO THE PLOTS.  IF NOT,
C----- SET THEM UP AND GO BACK TO PRINT THEM
      IF(IPASS) 170,210
  170 IPASS = 0
      NAMSED = 10H    ANNUAL
C-----COMPUTE THE ANNUAL TOTALS
      N2 = NYEARS
      N1 = NYEARS - 1
      DO 200 I = 2,NYEARS
      IF(NCOL(N1)) 180,70
  180 J1 = NCOL(N1)
      IF(NCOL(N1).EQ.NCOL(N2)) GO TO 185
      J2 = J1 + 1
      SEDNAT(N2,J2) = SEDNAT(N2,J2) - SEDNAT(N1,J1)
      SEDINC(N2,J2) = SEDINC(N2,J2) - SEDINC(N1,J1)
  185 DO 190 J = 1,J1
      SEDNAT(N2,J) = SEDNAT(N2,J) - SEDNAT(N1,J)
  190 SEDINC(N2,J) = SEDINC(N2,J) - SEDINC(N1,J)
      N2 = N1
      N1 = N1 - 1
  200 CONTINUE
      GO TO 70
C-----PLOT THE ANNUAL INCREASES
  210 WRITE (6,930) PLUNIT,DATIME,NAMSED
      WRITE (6,940)
  940 FORMAT(*0*35X*INCREASE*/* YEAR 0*12(10H.........+))
      DO 260 I = 1,NYEARS
      DO 220 J = 2,121
  220 POINT(J) = 1H
      POINT(1) = 1H.
      J1 = NCOL(I)
      IF(J1 - 1) 250,230,230
  230 DO 240 J = 1,J1
      K = (SEDINC(I,J)*0.1) + 1.5
      IF(K.GE.1.AND.K.LE.121) POINT(K) = CODE(J)
  240 CONTINUE
C-----PRINT THE LINE OF PLOT
  250 WRITE (6,950) YEARS(I),POINT
  950 FORMAT(1XI4,1X121A1)
  260 CONTINUE
C-----RETURN TO THE MAIN OVERLAY
      END
```

Program OLDNEW

```
      OVERLAY (OLAYS,3,0)
      PROGRAM OLDNEW
C-----COPY -SAVOLD- TO -SAVNEW-
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      DIMENSION BLOCK(1889),IO(9)
      CALL CORE (-1)
C-----WHEN AN END OF FILE IS SENSED ON AN IO READ, COPYING IS COMPLETE
      REWIND 14
   10 CALL GETREC (14,IO,9,IEND)
      IF(IEND) 60,20
   20 CALL PUTREC (15,IO,9)
C-----COPY ALL YEARS
   30 CALL GETREC (14,BLOCK,1889,IEND)
      IF(IEND) 50,40
   40 CALL PUTREC (15,BLOCK,1889)
      GO TO 30
   50 END FILE 15
      GO TO 10
   60 CONTINUE
      CALL CORE (0)
C-----RETURN TO THE MAIN OVERLAY
      END
```

Program COMPLN

```
      OVERLAY (OLAYS,4,0)
      PROGRAM COMPLN
C-----COMBINE THE MANAGEMENT PLANS INTO ONE PRINTOUT FOR A PLANNING UNIT
C----- AND ADD THE DATA TO THE REGIONAL FILE
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/P/NAME(2,15),NCOL(165),NPLAN,NUM(12),NVAR,OUT(165,12),
     1 VAR(15),YEAR(165)
      INTEGER YEAR
      DIMENSION LCOPY(14)
      INTEGER DATES(24)
      DATA NAME(1,1),NAME(2,1)/10H    GENERA,10HTED RUNOFF/
      DATA NAME(1,2),NAME(2,2)/10H       PRE,10HCIPITATION/
      DATA NAME(1,3),NAME(2,3)/10H  EVAPOTRA,10HNSPIRATION/
      DATA NAME(1,4),NAME(2,4)/10HCHANGE IN ,10HRECH. RED./
      DATA NAME(1,5),NAME(2,5)/10H CHANGE IN,10H PACK W.E./
      DATA NAME(1,6),NAME(2,6)/10H   APR 16-,10H30 GEN R O/
      DATA NAME(1,7),NAME(2,7)/10H     MAY 1-,10H15 GEN R O/
      DATA NAME(1,8),NAME(2,8)/10H   MAY 16-,10H30 GEN R O/
      DATA NAME(1,9),NAME(2,9)/10H    JUNE 1-,10H15 GEN R O/
      DATA NAME(1,10),NAME(2,10)/10H  JUNE 16-,10H30 GEN R O/
      DATA NAME(1,11),NAME(2,11)/10H   JULY 1-,10H15 GEN R O/
      DATA NAME(1,12),NAME(2,12)/10H         ,10H  PEAK W E/
      DATA NAME(1,13),NAME(2,13)/10H   DATE D,10HF PEAK W E/
      DATA NAME(1,14),NAME(2,14)/10H      PEAK,10H 7-DAY R O/
      DATA NAME(1,15),NAME(2,15)/10HDATE, PEAK,10H 7-DAY R O/
      CALL CORE (-1)
C-----COPY THE MANAGEMENT STRATEGY DESCRIPTION
      REWIND 18
      IF(PLNOPT(5).EQ.0.AND.PLNOPT(6).EQ.0.AND.PLNOPT(7).EQ.0.AND.
     1 PLNOPT(8).EQ.0.AND.PLNOPT(9).EQ.0) GO TO 9
      GO TO 6
    3 WRITE (6,900) LCOPY
  900 FORMAT(13A10,A6)
    6 READ (18,900) LCOPY
      IF(EOF(18)) 9,3
    9 CONTINUE
C-----PRINT THE INDICATED VARIABLES
      DO 180 NVAR = 1,15
      IF(NVAR.GT.5.AND.PLNOPT(NVAR+4).EQ.0) GO TO 180
      REWIND 12
C-----READ THE FIRST RECORD
      READ (12,910) NUM(1),YEAR(1),VAR
  910 FORMAT(I2,I3,3X15F6.2)
      OUT(1,1) = VAR(NVAR)
      NCOL(1) = 1
      NPLAN = 1
C-----FILL THE FIRST COLUMN
      DO 30 I = 2,NYEARS
      READ (12,910) MPLAN,IYEAR,VAR
C-----IF THIS IS STILL THE SAME PLAN, STORE THE INFORMATION
   10 IF(MPLAN - NUM(1)) 30,20
   20 YEAR(I) = IYEAR
      OUT(I,NPLAN) = VAR(NVAR)
      NCOL(I) = 1
   30 CONTINUE
C-----A MAXIMUM OF -NYEARS- YEARS MAY BE SUMMARIZED
      READ (12,910) MPLAN,IYEAR,VAR
      IF(EOF(12)) 150,40
   40 IF(MPLAN - NUM(1)) 80,50
   50 WRITE (6,920) NYEARS
  920 FORMAT(*0A MAXIMUM OF*I4,* YEARS MAY BE SUMMARIZED - THE BALANCE A
     1RE IGNORED*)
   60 READ (12,910) MPLAN,IYEAR,VAR
      IF(EOF(12)) 150,70
   70 IF(MPLAN - NUM(NPLAN)) 80,60
C-----FILL THE NEXT COLUMN (UP TO 12)
   80 IF(NPLAN - 12) 100,90,90
   90 WRITE (6,930)
  930 FORMAT(*0A MAXIMUM OF 12 PLANS MAY BE SUMMARIZED - THE BALANCE ARE
     1 IGNORED*)
      GO TO 150
  100 NPLAN = NPLAN + 1
      NUM(NPLAN) = MPLAN
C-----FIND THE FIRST YEAR AND STORE IT
      DO 110 N = 1,NYEARS
      IF(IYEAR - YEAR(N)) 110,120
  110 CONTINUE
      WRITE (6,940) MPLAN,IYEAR
  940 FORMAT(*0MANAGEMENT PLAN*I4,* STARTS WITH YEAR*I4,* WHICH WAS NOT
     1PART OF THE ORIGINAL TIME SPAN - JOB ABORTED*)
      CALL ABORT
  120 OUT(N,NPLAN) = VAR(NVAR)
      NCOL(N) = NCOL(N) + 1
C-----FILL THE REMAINDER OF THE COLUMN
      N = N + 1
      IF(N - NYEARS) 130,130,60
  130 DO 140 I = N,NYEARS
      READ (12,910) MPLAN,IYEAR,VAR
      OUT(I,NPLAN) = VAR(NVAR)
      NCOL(I) = NCOL(I) + 1
  140 CONTINUE
C-----GO BACK TO READ THE NEXT PLAN
      GO TO 60
C-----WRITE THE INFORMATION ON THE REGIONAL FILE
  150 IF(NVAR.GT.5) GO TO 156
      DO 155 I = 1,NYEARS
      N = NCOL(I)
      WRITE (13,945) YEAR(I),DECMAL,OUT(I,1),OUT(I,N),WEIGHT,NVAR
  945 FORMAT(I3,F3.2,3F10.5,I1)
  155 CONTINUE
C-----PRINT THE ARRAYS IF SPECIFIED
  156 IF(PLNOPT(NVAR+4).EQ.0) GO TO 180
      IF(PLNOPT(NVAR+4).EQ.2) GO TO 175
      DO 170 I = 1,NYEARS,55
      WRITE (6,950) PLUNIT,DATIME,NAME(1,NVAR),NAME(2,NVAR)
  950 FORMAT(*1*6A10,52X2A10/I13X2A10)
      WRITE (6,960) (NUM(N),N=1,NPLAN)
  960 FORMAT(*0    PLAN NUMBER*I5,11I10)
      WRITE (6,970)
  970 FORMAT(* YEAR*/)
      N1 = I
      N2 = I + 54
      IF(N2.GT.NYEARS) N2 = NYEARS
      IF(NVAR.EQ.13.OR.NVAR.EQ.15) GO TO 165
      DO 160 N = N1,N2
      J1 = NCOL(N)
      WRITE (6,980) YEAR(N),(OUT(N,J),J=1,J1)
  980 FORMAT(1XI5,5X12F10.2)
  160 CONTINUE
      GO TO 170
C-----CONVERT THE DATES FROM THE PSEUDO-JULIAN FORMAT
  165 DO 167 N = N1,N2
      J1 = NCOL(N)
      J2 = 1
      DO 166 J = 1,J1
      K = OUT(N,J)
      CALL GDATE (K,DATES(J2))
      J2 = J2 + 2
  166 CONTINUE
      J2 = J2 - 1
      WRITE (6,990) YEAR(N),(DATES(J),J=1,J2)
  990 FORMAT(1XI5,5X12(5XI2,*/*I2))
  167 CONTINUE
  170 CONTINUE
      IF(NVAR.LE.5.AND.PLNOPT(NVAR+4).EQ.1) GO TO 180
```

```
C-----COMPUTE THE DIFFERENCES BETWEEN THE NATURAL AND TREATED CONDITIONS
  175 CALL DIFFER
  180 CONTINUE
      CALL CORE (0)
C-----RETURN TO THE PRIMARY OVERLAY
      END
```

Subroutine DIFFER

```
      SUBROUTINE DIFFER
C-----COMPUTE AND PRINT THE DIFFERENCES CAUSED BY THE TREATMENTS
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),RECOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEORN2
      COMMON/P/NAME(2,15),NCOL(165),NPLAN,NUM(12),NVAR,OUT(165,12),
     1 VAR(15),YEAR(165)
      INTEGER YEAR
      DIMENSION IOUT(12)
      INTEGER ODD(6)
      DATA ODD/62,154,155,217,279,372/
      DO 110 I = 1,NYEARS,55
      WRITE (6,910) PLUNIT,DATIME,NAME(1,NVAR),NAME(2,NVAR)
  910 FORMAT(*1*6A10,52X2A10/* EFFECTS OF TREATMENT COMPARED WITH NATURA
     1L CONDITIONS (DECREASE INDICATED BY -)*33X2A10)
      WRITE (6,920) (NUM(N),N=1,NPLAN)
  920 FORMAT(*0    PLAN NUMBER*I5,11I10)
      WRITE (6,930)
  930 FORMAT(* YEAR*/)
      N1 = I
      N2 = I + 54
      IF(N2.GT.NYEARS) N2 = NYEARS
      DO 100 N = N1,N2
      J1 = NCOL(N)
      IF(J1 - 1) 20,10
C-----NO TREATMENT
   10 WRITE (6,940) YEAR(N)
  940 FORMAT(1XI5,15X11F10.2)
      GO TO 100
C-----GET THE DIFFERENCES
   20 IF(NVAR.EQ.13.OR.NVAR.EQ.15) GO TO 40
      DO 30 J = 2,J1
   30 OUT(N,J) = OUT(N,J) - OUT(N,1)
      WRITE (6,940) YEAR(N),(OUT(N,J),J=2,J1)
      GO TO 100
C-----DATES
   40 I1 = OUT(N,1)
      DO 90 J = 2,J1
      I2 = OUT(N,J)
      IOUT(J) = I2 - I1
C-----CHECK FOR ODD DAYS BETWEEN THEM
      IF(IOUT(J)) 50,90,70
C-----I1 IS LARGER
   50 DO 60 K = 1,6
      IF(I2.LE.ODD(K).AND.ODD(K).LE.I1) IOUT(J) = IOUT(J) + 1
   60 CONTINUE
      GO TO 90
C-----I2 IS LARGER
   70 DO 80 K = 1,6
      IF(I1.LE.ODD(K).AND.ODD(K).LE.I2) IOUT(J) = IOUT(J) - 1
   80 CONTINUE
   90 OUT(N,J) = IOUT(J)
      WRITE (6,950) YEAR(N),(IOUT(J),J=2,J1)
  950 FORMAT(1XI5,15X11I10)
  100 CONTINUE
  110 CONTINUE
C-----PLOT THE DIFFERENCES
      WRITE (6,910) PLUNIT,DATIME,NAME(1,NVAR),NAME(2,NVAR)
      IF(NVAR.EQ.13.OR.NVAR.EQ.15) GO TO 120
      WRITE (6,960)
  960 FORMAT(*0*35X*DECREASE*52X*INCREASE*)
      CALL PLOTD (10.0)
      RETURN
  120 WRITE (6,970)
  970 FORMAT(*0*36X*EARLIER*52X*LATER*)
      CALL PLOTD (1.0)
      RETURN
      END
```

Subroutine PLOTD

```
      SUBROUTINE PLOTD (SCALE)
C-----PLOT THE DIFFERENCES
      COMMON DATIME(2),DECMAL,NRMANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEORN2
      COMMON/P/NAME(2,15),NCOL(165),NPLAN,NUM(12),NVAR,OUT(165,12),
     1 VAR(15),YEAR(165)
      INTEGER YEAR
      INTEGER CODE(11),POINT(121)
      DATA CODE/1M1,1M2,1M3,1M4,1M5,1M6,1M7,1M8,1M9,1MA,1MB/
      WRITE (6,910)
  910 FORMAT(* YEAR *,6(10H-.........),1H0,6(10H.........+))
      DO 50 I = 1,NYEARS
      DO 10 J = 1,121
   10 POINT(J) = 1H
      POINT(61) = 1H.
      J1 = NCOL(I)
      IF(J1 - 1) 20,40
C-----SCALE AND TRANSLATE THE DIFFERENCES, THEN STORE THE CODE
   20 DO 30 J = 2,J1
      K = (OUT(I,J)*SCALE) + 61.5
      IF(K.GE.1.AND.K.LE.121) POINT(K) = CODE(J-1)
   30 CONTINUE
C-----WRITE THE LINE
   40 WRITE (6,920) YEAR(I),POINT
  920 FORMAT(1XI5,121A1)
   50 CONTINUE
      END
```

Program COMRGN

```
      OVERLAY (DLAYS,5,0)
      PROGRAM COMRGN
C-----COMBINE THE PLANNING UNITS INTO A REGION
      COMMON DATIME(2),DECMAL,NRMANC,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),RECOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,REGION,RECOPT,SAVE,SEORN2
      DIMENSION OUT(165,10),WT(5)
      INTEGER YEAR(165)
      DIMENSION NAME(2,5)
      DATA NAME(1,1),NAME(2,1)/10H    GENERA,10HTED RUNOFF/
      DATA NAME(1,2),NAME(2,2)/10H       PRE,10HCIPITATION/
      DATA NAME(1,3),NAME(2,3)/10H  EVAPOTRA,10HNSPIRATION/
      DATA NAME(1,4),NAME(2,4)/10HCHANGE IN ,10HRECH. REQ./
      DATA NAME(1,5),NAME(2,5)/10H CHANGE IN,10H PACK W.E./
      CALL CORE (-1)
      REWIND 13
      DO 5 I = 1,NYEARS
    5 READ (13,910) YEAR(I)
      REWIND 13
      DO 10 I = 1,5
   10 WT(I) = 0.0
      DO 20 J = 1,10
      DO 20 I = 1,165
   20 OUT(I,J) = 0.0
C-----READ THE FIRST RECORD OF A VARIABLE FOR A PLANNING UNIT
   30 READ (13,910) IYEAR,UNALT,ALT,WEIGHT,NVAR
  910 FORMAT(I3,3X3F10.5,I1)
      IF(EOF(13)) 60,40
C-----ACCUMULATE THE WEIGHT
   40 WT(NVAR) = WT(NVAR) + WEIGHT
      IF(IYEAR.NE.YEAR(1)) GO TO 150
C-----ACCUMULATE THE WEIGHTED VALUES
      NVAR5 = NVAR + 5
      OUT(1,NVAR) = OUT(1,NVAR) + (UNALT * WEIGHT)
      OUT(1,NVAR5) = OUT(1,NVAR5) + (ALT * WEIGHT)
      DO 50 I = 2,NYEARS
      READ (13,910) IYEAR,UNALT,ALT
      IF(IYEAR.NE.YEAR(I)) GO TO 150
      OUT(I,NVAR) = OUT(I,NVAR) + (UNALT * WEIGHT)
      OUT(I,NVAR5) = OUT(I,NVAR5) + (ALT * WEIGHT)
   50 CONTINUE
      GO TO 30
C-----PRINT EACH VARIABLE AS NEEDED
   60 DO 140 NVAR = 1,5
      IF(REGOPT(NVAR).EQ.0) GO TO 140
      IF(WT(NVAR)) 70,140
   70 WRITE (6,920) REGION,DATIME,NAME(1,NVAR),NAME(2,NVAR)
  920 FORMAT(*1*8A10,32X2A10/* REGIONAL SUMMARY*96X2A10)
      NVAR5 = NVAR + 5
      IF(WT(NVAR).GE.0.99.AND.WT(NVAR).LE.1.01) GO TO 78
      WRITE (6,930) WT(NVAR)
  930 FORMAT(*0- - - - N O T E - - - - THE COMBINED WEIGHTS OF THE PLANN
     1ING UNITS IS*F5.2,* AS OPPOSED TO THE NORMAL 1.0 - - - - N O T E -
     2 - - -*/25X*THEREFORE, ALL VALUES BELOW ARE ADJUSTED RESULTS, MADE
     3 TO CORRESPOND TO THE NORM*)
      DO 74 I = 1,NYEARS
      OUT(I,NVAR) = OUT(I,NVAR)/WT(NVAR)
   74 OUT(I,NVAR5) = OUT(I,NVAR5)/WT(NVAR)
   78 WRITE (6,940)
  940 FORMAT(*0*3(6X*YEAR   NATURAL    MANAGED*10X)/)
      DO 130 I = 1,55
      IF(I - NYEARS) 80,80,140
   80 J = I + 55
      IF(J - NYEARS) 100,100,90
   90 WRITE (6,950) YEAR(I),OUT(I,NVAR),OUT(I,NVAR5)
  950 FORMAT(1X3(I10,2F10.2,10X))
      GO TO 130
  100 K = J + 55
      IF(K - NYEARS) 120,120,110
  110 WRITE (6,950) YEAR(I),OUT(I,NVAR),OUT(I,NVAR5),YEAR(J),
     1 OUT(J,NVAR),OUT(J,NVAR5)
      GO TO 130
  120 WRITE (6,950) YEAR(I),OUT(I,NVAR),OUT(I,NVAR5),YEAR(J),
     1 OUT(J,NVAR),OUT(J,NVAR5),YEAR(K),OUT(K,NVAR),OUT(K,NVAR5)
  130 CONTINUE
  140 CONTINUE
      GO TO 160
C-----THE YEARS ON THE VARIOUS UNITS DO NOT MATCH
  150 WRITE (6,960)
  960 FORMAT(*0THE YEARS PROCESSED ON THE VARIOUS UNITS WERE NOT CONSIST
     1ENT, SO THE REGIONAL SUMMARY IS BEING OMITTED*)
  160 CALL CORE (0)
C-----RETURN TO THE PRIMARY OVERLAY
      END
```

Program LSTSAV

```
      OVERLAY (DLAYS,6,0)
      PROGRAM LSTSAV
C-----LIST THE FILES ON -SAVNEW-
      COMMON DATIME(2),DECMAL,NRNANG,NSAVED,NYEARS,PLNOPT(19),PLUNIT(6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEORN2,WEIGHT
      INTEGER DATIME,PLNOPT,PLUNIT,RECOVR,RECION,REGOPT,SAVE,SEORN2
      DIMENSION BLOCK(1889),ID(9)
      CALL CORE (-1)
      END FILE 15
      REWIND 15
      WRITE (6,910) DATIME
  910 FORMAT(*1LISTING OF FILES ON -SAVNEW- AS OF *2A10/
     1 *0*6X*FILE      NUMBER      FIRST        LAST*/
     2 5X *NUMBER      YEARS       YEAR         YEAR*10X*PLANNING UNIT ID*)
      IFILE = 0
C-----GET AN ID RECORD
   10 CALL GETREC (15,ID,9,IEND)
      IF(IEND) 50,20
C-----GET THE FIRST YEAR, THEN THE LAST
   20 IFILE = IFILE + 1
      CALL GETREC (15,BLOCK,1889,IEND)
      FIRST = BLOCK(1)
   30 DLAST = BLOCK(1)
```

```
      CALL GETREC (15,BLOCK,1889,IEND)
      IF(IEND) 40,30
   40 WRITE (6,920) IFILE,IDI7),FIRST,OLAST,(ID(I),I=1,6)
  920 FORMAT(*0*2I10,2F10.2,10X6A10)
      GO TO 10
   50 CONTINUE
C-----RETURN TO THE PRIMARY OVERLAY
      END
```

Program PROOF

```
      OVERLAY (OLAYS,7,0)
      PROGRAM PRODF
C-----PROOFREAD THE PARAMETER OECK
      COMMON DATIME(2),OECMAL,NRMANG,NSAVEO,NYEARS,PLNOPT(19),PLUNITI6),
     1 RECOVR,REGION(8),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER DATIME,PLNDPT,PLUNIT,RECOVR,REGION,REGOPT,SAVE,SEDRN2
      COMMON/S/AVSOIL(I1),DECLINIII),NROADS,RATNRM(1I),ROADMII1I),
     1 ROADW(I1),TANCUT(11),TANFILI1I),TANRHD(I1),YRCNSTI1I)
      INTEGER YRCNST
      OIMENSION CARD(5),DATCRDI8),IDATESI6),PARAM(9)
      CALL CORE (-I)
C-----READ THE REGION CARDS
      READ (5,91D) NAME,NYEARS,SEDRN2,SAVE,RECOVR,REGOPT,REGION
  91D FORMAT(A6,4X4I5,5(1/8A1D)
      IF(NAME.ED.6HREGION) GO TO 1D
      WRITE I6,92D)
  920 FORMAT(*OTHE FIRST INPUT CARD IS NOT THE REGION CARD*)
      CALL PRABRT
   10 IF(NYEARS.GT.D.ANO.NYEARS.LE.I65) GO TO 20
      WRITE (6,930) NYEARS
  93D FORMAT(*DTHE NUMBER OF YEARS (*I3,*) IS NOT BETWEEN 1 ANO 165*)
      CALL PRABRT
C-----READ A PLANNING UNIT CARD
   20 READ (5,94D) PLUNIT,DECMAL,INFILE,WEIGHT,(PLNOPT(I),I=1,10),
     1 PLNOPT(16),PLNOPTII8)
  940 FORMAT(6A10,F2.2,1XI2,F3.2,12I1)
      IF(EOF(5)) 120,30
C-----IF THIS IS A RECOVERY DECK, COPY IT TO THE REGION FILE
   30 IF(PLUNIT(1).NE.IDHRECOVERY D) GO TO 5D
   4D READ (5,950) CARD
  950 FORMAT(2A10,A6,F1D.5,A1)
      IFICARD(1).EO.1DHENO OF REC) GO TO 20
C-----IF A NEW WEIGHT WAS SPECIFIED, REPLACE THE ONE ON THE CARD
      IF(WEIGHT.GT.O.D) CARO(4) = WEIGHT
      WRITE (13,950) CARD
      GO TO 40
C-----IF THIS IS A DATA OECK, COPY IT TO THE UNEDITED DATA FILE
   50 IF(PLUNITI1).NE.10HOATA DECK ) GO TO 58
   52 READ (5,955) DATCRO
  955 FORMAT(8A10)
      IFIDATCRD(1).EO.10HENO OF DAT) GO TO 54
      WRITE (10,955) DATCRD
      GO TO 52
   54 END FILE 10
      GO TO 2G
C-----OEFINE THE REMAINING OPTIONS
   58 PLNOPT(I1) = PLNOPTI10)
      PLNOPT(I2) = PLNOPT(ID)
      PLNOPTI13) = PLNOPT(IO)
      PLNOPT(I4) = PLNOPTI10)
      PLNOPTI15) = PLNOPT(10)
      PLNOPT(I7) = PLNOPT(I6)
      PLNOPT(19) = PLNOPT(18)
C-----WRITE THE RECORD
      WRITF (19) PLUNIT,DECMAL,INFILE,WEIGHT,PLNOPT
      LAST1 = 0
C-----IF THE INPUT UNIT IS 14, THE NORMAL SIMULATION WILL NOT BE
C----- PERFORMEO.  BUT IF IT IS NOT I4, READ THE STATION PARAMETERS
      IF(INFILE - I4) 60,80
   60 CALL PARAMS
C-----READ THE SPECIFIEO CONOITIONS CARDS
   70 READ (5,960) NAME,PEAKWE,IOATES
  960 FORMAT(A10,IOXF5.2,6X3I2,1X3I2)
      WRITE (19) NAME,PEAKWE,IDATES
      IF(NAME.EO.10HSPECIFIEO ) GO TO 70
      IF(NAME.EO.IOHEND OF NAT) GO TO 80
      WRITE (6,970) NAME,PLUNIT
  970 FORMAT(*OA SPECIFIED CONDITIONS CARO WAS EXPECTED UNDER PLANNING U
     1NIT *6A10/*  BUT COL I-IO OF THE CARD READ CONTAIN *A10)
      CALL PRABRT
C-----READ THE MANAGEMENT STRATEGY OECK
   80 READ (5,980) NAME,NUM,NEXTYR,PARAM,SPECCD
  980 FORMAT(A10,IOX2I5,10F5.0)
      WRITE II9) NAME,NUM,NEXTYR,PARAM,SPECCD
      IF(NAME.NE.IOHMANAGEMENT.AND.NAME.NE.1OHROAD CONST) GO TO 110
      IF(LAST1 - NEXTYR) 90,80,100
   90 LAST1 = NEXTYR
      GO TO 80
  10G WRITE (6,985) PLUNIT
  985 FORMAT(*OON PLANNING UNIT *6A10/*  THE MANAGEMENT PLAN CAROS ARE N
     1OT IN ORDER BY YEAR*)
      CALL PRABRT
  110 IF(NAME.EO.1OHENO OF STR) GO TO 20
      WRITE (6,990) NAME
  990 FOPMAT(*0A MANAGEMENT PLAN OR ROAD CONSTRUCTION CARO HAS EXPECTED
     1UNDER PLANNING UNIT*/2X6A10/*  BUT COL 1-10 OF THE CARD READ CONTA
     2IN *AI0)
      CALL PRABRT
C-----PROOFREADING COMPLETE
  120 END FILE 19
      REWINO I9
      NSAVED = C
C-----GET THE DATE AND TIME OF THIS RUN
      CALL DATE (DATIME(I))
      CALL TIME (DATIME(2))
      CALL CORE (0)
C-----RETURN TO THE MAIN OVERLAY
      END
```

Subroutine GETFMT

```
      SUBROUTINE GETFMT
C-----GET THE FORMAT-INDICES CARD AND CHECK FOR ERRORS
      INTEGER VARFMT(7)
      IERR = 0
C-----READ THE CARD
      READ (5,910) NAME,VARFMT,NF(LE,IM,ID,IY,IMX,(MN,IP
  910 FORMAT(A6,6A10,A4,1X(2,1X6I1)
      IF(NAME.ED.6HFDRMAT) GO TO ID
      WRITE (6,920) NAME
  920 FORMAT(*DTHE VARIABLE FORMAT CARD WAS EXPECTED, BUT CDL 1-6 OF THE
     1 CARD READ CONTAIN *A6)
      CALL PRABRT
C-----CERTIFY THE VALIDITY OF THE INDICES - START WITH THE MONTH
   IC NAME = 1CHMONTH   75
      IF(IM.GT.D.AND.IM.LT.7) GO TO 2D
      WRITE (6,93C) NAME,(M
  93D FCRMAT(1XAI0,I6,* FORMAT CARD, INVAL(D INDEX - MUST BE 1 TD 6 IN I
     1NDICATED COLUMN*)
      IERR = 1
C-----DAY
   2D NAME = 1DHDAY     76
      IF(ID.GT.C.AND.ID.LT.7) GO TD 3D
      WRITE (6,930) NAME,ID
      IERR = 1
      GO TO 50
   3D IFIID.NE.IM) GO TD 5D
      WRITE (6,95D) NAME,ID
  95D FDRMAT(1XA10,I6,* FORMAT CARO, THIS INDEX HAS BEEN USED PREVIOUSLY
     1*)
      IERR = 1
C-----YEAR
   50 NAME = 1OHYEAR    77
      IFIIY.GT.C.AND.IY.LT.7) GO TO 6D
      WRITE (6,930) NAME,IY
      IERR = 1
      GO TD 80
   60 IF(IY.NE.IM.AND.IY.NE.ID) GO TO 8D
      WRITE (6,950) NAME,IY
      IERR = 1
C-----MAXIMUM TEMPERATURE
   80 NAME = 1DHMAX TEM 78
      IF(IMX.GT.D.AND.(MX.LT.7) GO TO 9D
      WRITE I6,930) NAME,IMX
      IERR = 1
      GO TO II0
   90 IFIIMX.NE.IM.AND.IMX.NE.ID.AND.IMX.NE.IY) GO TO 110
      WRITE (6,95D) NAME,IMX
      IERR = I
C-----MINIMUM TEMPERATURE
  110 NAME = 1DHMIN TEM 79
      IF(IMN.GT.O.AND.IMN.LT.7) GO TO 120
      WRITE (6,930) NAME,IMN
      IERR = 1
      GO TO 140
  120 IF(IMN.NE.IM.AND.IMN.NE.ID.AND.IMN.NE.IY.ANO.IMN.NE.IMX) GO TO 140
      WRITE (6,950) NAME,IMN
      IERR = 1
C-----PRECIP
  I40 NAME = 1OHPRECIP  80
      IFIIP.GT.O.ANO.IP.LT.7) GO TO 150
      WRITE (6,930) NAME,IP
      IERR = I
      GO TO 170
  150 IFIIP.NE.IM.AND.IP.NE.ID.ANO.IP.NE.IY.ANO.IP.NE.IMX.AND.IP.NE.IMN)
     1 GO TO I70
      WRITE (6,950) NAME,IP
      IERR = 1
C-----CHECK FOR ERRORS
  I70 IFIIERR) 190,180
  180 WRITE II9) VARFMT,NFILE,IM,IO,IY,IMX,IMN,IP
      RETURN
  190 CALL PRABRT
      ENO
```

Subroutine GETPOT

```
      SUBROUTINE GETPOT (LAT,ASPECT,SLOPE)
C-----OEFINE THE POTENTIAL RADIATION VALUES AND THE SLOPE/ASPECT
C----- ADJUSTMENT FACTORS (THE TABLES ARE FROM -POTENTIAL SOLAR BEAM
C----- IRRADIATION ON SLOPES- BY FRANK AND LEE, 1966.  ONLY THOSE
C----- PORTIONS OF THE TABLES PERTAINING TO THE CENTRAL ROCKY MOUNTAINS
C----- (LATITUDE 38 - 44) ARE INCLUDEO.  LIKEWISE, UNMANAGEABLE SLOPES
C----- (GREATER THAN 40 PERCENT) WERE ELIMINATED
      DIMENSION L(1924)
      DIMENSION POTENT(24),SLPASP(24)
      INTEGER ASPECT,SLOPE
C*****LATITUDE 38
C-----HORIZONTAL SURFACE
      DATA (L(I),I=I,I3)/
     1 1020,1004,974,930,872,802,722,639,558,485,425,383,359/
C-----N ASPECT
      OATA (L(I),I=14,65)/
     1 1022,1000,962,907,837,754,662,569,480,402,340,297,273,
     2 1013, 987,942,877,794,700,597,495,401,319,257,214,190,
     3  996, 965,913,839,746,641,530,420,322,240,178,138,115,
     4  971, 937,879,797,695,581,461,346,246,165,107, 71, 53/
C-----S ASPECT
      DATA (L(I),I=66,117)/
     I 1011, 999,977,944,898,842,775,703,630,563,507,467,443,
     2  994, 986,972,949,916,873,819,758,695,634,582,545,522,
     3  971, 967,960,947,925,895,854,805,751,697,650,614,593,
     4  942, 943,942,938,927,909,880,843,798,751,708,675,655/
C-----NNE OR NNW ASPECT
      DATA (L(I),I=118,169)/
     I 1021,1000,963,909,839,757,667,575,487,409,347,304,280,
     2 1012, 987,943,879,799,707,6D8,5D8,415,335,272,229,2D5,
     3  994, 965,915,843,754,653,547,442,346,264,202,I6I,138,
     4  969, 937,881,802,7D5,598,486,377,281,200,I41,I02, 8I/
C-----SSE OR SSW ASPECT
      DATA (L(I),I=17D,221)/
```

```
     1 1010, 999,977,943,896,839,771,698,625,557,501,460,437,
     2  996, 988,973,949,914,868,812,749,684,622,570,532,509,
     3  976, 972,963,948,924,890,845,792,735,679,631,596,574,
     4  957, 956,947,941,927,903,869,826,778,728,684,651,631/
C-----NE OR NW ASPECT
      DATA (L(I),I=222,273)/
     1 1020,1000,965,913,846,768,680,590,504,428,366,324,299,
     2 1011, 987,947,889,815,730,636,541,452,374,312,269,245,
     3  993, 967,923,860,781,690,592,494,403,324,263,222,198,
     4  969, 941,894,827,744,649,549,450,359,281,222,182,159/
C-----SE OR SW ASPECT
      DATA (L(I),I=274,325)/
     1 1014,1000,976,947,891,830,760,684,609,540,483,442,418,
     2 1003, 993,974,945,905,854,792,724,655,590,535,496,473,
     3  980, 981,967,946,913,871,817,757,693,633,581,544,521,
     4  969, 965,956,941,916,882,836,783,725,669,621,585,563/
C-----ENE OR WNW ASPECT
      DATA (L(I),I=326,377)/
     1 1019,1001,968,920,857,783,700,613,529,454,394,352,327,
     2 1011, 991,956,905,840,762,676,587,502,427,366,324,300,
     3  997, 976,940,887,819,740,652,563,478,402,342,301,277,
     4  978, 957,920,866,797,718,630,540,456,381,327,281,258/
C-----ESE OR WSW ASPECT
      DATA (L(I),I=378,429)/
     1 1016,1001,975,935,882,817,743,664,586,515,457,415,391,
     2 1008, 995,972,937,888,829,760,685,611,542,485,445,421,
     3  997, 986,966,935,891,837,773,703,637,566,511,471,448,
     4  983, 973,956,929,891,842,782,717,649,586,532,494,471/
C-----E OR W ASPECT
      DATA (L(I),I=430,481)/
     1 1019,1001,972,928,870,801,722,639,558,485,426,384,359,
     2 1011, 994,965,927,866,797,719,638,558,486,427,385,361,
     3 1001, 984,956,914,859,792,716,636,557,486,428,387,363,
     4  986, 970,944,903,850,785,711,633,556,486,429,389,366/
C*****LATITUDE 40
C-----HORIZONTAL SURFACE
      DATA IL(I),I=482,494)/
     1 1022,1004,971,923,860,786,702,615,531,456,395,353,328/
C-----N ASPECT
      DATA (L(I),(=495,546)/
     1 1021, 998,957,898,823,735,640,543,452,373,310,267,243,
     2 1010, 982,934,865,778,679,573,468,372,290,227,185,162,
     3  991, 958,903,825,728,619,503,391,292,210,150,111, 90,
     4  964, 928,867,780,674,556,433,316,216,137, 82, 48, 32/
C-----S ASPECT
      OATA (LII),I=547,598)/
     1 1015,1001,977,940,890,829,757,681,605,536,478,437,413,
     2 1001, 992,975,948,911,863,804,739,672,608,555,515,492,
     3  980, 975,965,949,923,888,842,788,730,673,623,586,564,
     4  954, 953,950,942,927,904,871,828,779,729,683,648,627/
C-----NNE OR NNW ASPECT
      OATA (LII),(=599,650)/
     1 1021, 998,958,899,825,739,645,549,459,380,317,274,250,
     2 1010, 982,935,868,783,687,584,481,386,305,242,200,176,
     3  990, 959,905,829,736,631,521,414,317,235,174,134,112,
     4  963, 928,869,786,685,574,459,349,252,173,114, 78, 59/
C-----SSE OR SSW ASPECT
      OATA (L(I),I=651,702)/
     1 1016,1002,977,939,888,826,753,676,600,529,472,431,407,
     1 1003, 993,975,947,908,858,797,729,661,596,542,503,479,
     3  985, 979,968,949,921,882,832,775,714,655,604,567,545,
     4  961, 959,954,944,926,898,859,811,758,705,659,624,602/
C-----NE OR NW ASPECT
      OATA (L(I),I=703,754)/
     1 1020, 998,960,904,833,750,659,565,477,399,337,294,269,
     2 1009, 984,941,879,801,711,613,515,424,345,283,240,216,
     3  989, 962,915,848,764,669,568,468,375,296,235,194,171,
     4  964, 935,884,814,726,628,525,423,332,254,195,156,135/
C-----SE OR SW ASPECT
      OATA (LII),I=755,806)/
     1 1017,1002,976,935,882,817,742,662,584,512,454,412,388,
     2 1008, 997,976,943,898,842,775,703,631,563,507,467,443,
     3  995, 987,971,945,909,861,803,738,671,608,554,515,492,
     4  978, 972,961,943,914,875,824,766,705,645,595,557,535/
C-----ENE OR WNW ASPECT
      OATA (L(I),(=807,858)/
     1 1020,1002,964,912,845,766,679,589,502,426,364,322,297,
     2 1011, 989,951,897,827,745,655,563,475,398,337,295,271,
     3  996, 973,934,878,806,723,631,538,451,375,314,273,249,
     4  977, 954,914,857,784,700,609,516,430,354,295,255,231/
C-----ESE OR WSW ASPECT
      OATA (L(I),I=859,910)/
     1 1019,1002,973,929,872,802,724,641,560,487,427,385,361,
     2 1012, 997,971,932,880,816,742,663,586,515,457,416,391,
     3 1002, 989,967,932,884,826,757,683,609,540,483,443,419,
     4  989, 978,958,928,885,832,768,698,627,561,506,466,442/
C-----E OR W ASPECT
      OATA (LII),I=911,962)/
     1 1020,1001,969,921,859,785,702,615,532,457,396,354,329,
     2 1013, 995,963,916,855,782,700,615,532,458,398,356,332,
     3 1002, 984,954,908,849,778,697,614,532,459,400,359,335,
     4  988, 972,942,898,841,772,694,612,532,460,402,361,338/
C*****LATITUDE 42
C-----HORIZONTAL SURFACE
      OATA (L(I),I=963,975)/
     1 1023,1003,967,915,849,769,681,591,504,427,366,323,298/
C-----N ASPECT
      DATA (L(I),I=976,1027)/
     1 1020, 995,951,888,808,716,617,517,424,343,280,238,213,
     2 1007, 977,925,852,760,657,547,440,342,260,198,157,134,
     3  985, 951,892,810,708,595,476,362,262,181,122, 85, 65,
     4  957, 919,854,763,653,531,404,286,186,109, 57, 28, 14/
C-----S ASPECT
      OATA (L(I),I=1028,1079)/
     1 1018,1003,976,935,880,815,739,659,580,508,449,407,383,
     2 1007, 996,976,946,904,851,788,719,649,582,526,486,462,
     3  989, 982,970,949,919,879,829,771,709,648,596,557,534,
     4  965, 962,957,945,926,898,860,813,760,705,657,620,597/
C-----NNE OR NNW ASPECT
      DATA (LI(),(=1080,1131)/
     1 102 , 995,952,889,811,720,622,523,431,350,287,245,220,
     2 1017, 977,927,855,766,666,559,454,357,276,213,172,148,
     3  985, 952,895,815,717,608,495,385,288,206,146,107, 86,
     4  956, 927,857,770,664,549,432,320,224,145, 89, 55, 38/
C-----SSE OR SSW ASPECT
      DATA (L(I),I=1132,1183)/
     1 1019,1003,975,934,878,811,735,654,574,502,442,401,376,
     2 1009, 997,977,945,901,846,781,709,637,570,513,473,449,
     3  993, 985,971,949,917,873,818,756,692,630,577,538,515,
     4  972, 968,961,947,925,892,848,795,738,682,633,596,573/
C-----NE OR NW ASPECT
      OATA (L((),I=1184,1235)/
     1 102., 996,955,895,819,732,636,540,449,369,307,264,240,
     2 1007, 980,934,868,785,691,590,489,396,316,254,212,188,
     3  986, 956,906,835,747,648,544,441,347,268,208,167,145,
     4  959, 927,874,800,708,607,500,397,305,227,170,132,111/
C-----SE OR SW ASPECT
      OATA (L(I),I=1236,1287)/
     1 1027,1003,974,930,872,802,722,639,558,484,424,382,358,
     2 1013,1000,976,939,890,829,758,682,606,536,478,437,413,
     3 1012, 992,973,944,903,851,788,719,648,582,526,486,462,
     4  986, 979,966,944,910,867,811,749,684,621,568,529,505/
C-----ENE OR WNW ASPECT
      DATA (L(I),I=1288,1339)/
     1 1021, 998,960,904,832,749,657,563,475,397,335,292,268,
     2 1010, 987,946,887,813,727,633,538,448,370,308,266,242,
     3  994, 970,928,868,792,704,609,514,425,347,286,245,221,
     4  975, 950,908,847,770,682,587,492,404,328,268,228,205/
C-----ESE OR WSW ASPECT
      DATA ILII),I=1340,1391)/
     1 1021,1003,970,923,861,787,704,617,534,458,398,355,331,
     2 1015, 999,970,927,870,802,723,641,561,487,428,386,362,
     3 1006, 992,967,928,876,813,740,662,584,513,455,414,389,
     4  995, 982,960,926,879,821,752,678,604,535,478,437,413/
C-----E OR W ASPECT
      OATA (LII),I=1392,1443)/
     1 1021,1001,965,914,847,768,681,591,505,428,367,324,299,
     2 1014, 994,960,909,843,766,680,591,506,430,369,327,302,
     3 1003, 984,951,902,838,762,678,591,507,432,372,330,306,
     4  990, 972,940,892,831,758,675,590,508,434,375,334,310/
C*****LATITUDE 44
C-----HORIZONTAL SURFACE
      OATA IL(I),I=1444,1456)/
     1 1024,1001,963,907,835,751,659,565,476,398,336,293,268/
C-----N ASPECT
      OATA IL(I),I=1457,1508)/
     1 1018, 991,944,877,792,696,593,490,395,314,251,208,184,
     2 1003, 971,916,838,742,635,521,411,313,230,169,129,107,
     3  980, 943,881,794,688,571,448,332,232,152, 96, 61, 43,
     4  949, 909,841,746,631,505,375,256,157, 83, 35, 11,  2/
C-----S ASPECT
      OATA (LII),I=1509,1560)/
     1 1021,1004,974,929,870,800,719,636,554,480,419,377,352,
     2 1012, 999,977,943,897,839,771,698,624,555,497,456,431,
     3  996, 988,973,949,914,870,815,752,686,622,568,527,503,
     4  975, 971,963,948,924,892,849,797,739,681,630,591,567/
C-----NNE OR NNW ASPECT
      OATA IL(I),I=1561,1612)/
     1 1018, 991,945,878,795,700,598,496,402,321,258,215,191,
     2 1003, 972,918,842,749,644,533,425,328,246,184,144,121,
     3  980, 944,884,800,697,584,468,357,258,178,119, 82, 63,
     4  949, 910,845,753,643,524,404,292,195,119, 66, 35, 20/
C-----SSE OR SSW ASPECT
      OATA (L(I),I=1613,1664)/
     1 1021,1004,973,928,868,796,715,630,548,473,413,371,346,
     2 1013,1000,977,942,893,834,763,688,612,542,485,443,418,
     3  999, 991,974,948,911,863,804,737,669,604,549,509,484,
     4  981, 976,966,949,922,885,836,778,717,657,606,567,543/
C-----NE OR NW ASPECT
      OATA (LII),I=1665,1716)/
     1 1018, 993,948,885,804,712,613,513,420,340,277,235,211,
     2 1004, 975,926,856,769,670,565,462,367,287,225,184,160,
     3  982, 950,897,822,730,627,519,414,319,240,180,141,119,
     4  953, 920,864,785,690,585,475,371,278,201,145,108, 88/
C-----SE OR SW ASPECT
      DATA (LII),I=1717,1768)/
     1 1022,1004,971,923,861,786,702,615,531,456,395,352,327,
     2 1017,1002,975,935,881,816,740,660,581,509,449,407,382,
     3 1007, 996,974,942,896,840,772,699,625,555,498,457,432,
     4  994, 985,969,944,906,857,798,731,661,596,540,500,476/
C-----ENE OR WNW ASPECT
      OATA (LII),I=1769,1820)/
     1 1020, 996,954,894,818,730,634,538,447,368,305,262,238,
     2 1009, 983,940,877,798,708,610,512,420,341,279,237,213,
     3  993, 966,922,857,777,685,587,488,398,319,258,217,194,
     4  973, 946,901,836,755,664,565,468,378,301,242,202,180/
C-----ESE OR WSW ASPECT
      OATA (L(I),(=1821,1872)/
     1 1022,1002,967,915,849,770,683,593,507,430,368,325,301,
     2 1018,1000,968,921,860,787,704,618,535,459,399,356,331,
     3 1010, 994,966,924,868,800,722,640,560,486,426,384,359,
     4 1000, 986,961,923,872,809,736,658,581,509,451,409,384/
C-----E OR W ASPECT
      OATA (LII),I=1873,1924)/
     1 1021, 999,961,905,834,751,659,566,477,399,337,294,270,
     2 1014, 993,955,901,831,749,659,566,479,401,340,297,273,
     3 1004, 984,947,894,826,746,658,567,481,404,344,301,277,
     4  992, 972,937,886,820,742,656,568,483,408,348,306,282/
C-----IF ALL ARE BLANK, READ THE INFORMATION FROM CARDS
      IF(LAT.EO.0.ANO.ASPECT.EO.3H   .ANO.SLOPE.EO.0) GO TO 330
C-----FIND THE LATITUDE IN THE TABLE
      IF(LAT - 38) 10,20,30
   10 WRITE (6,910) LAT
  910 FORMAT(*0LATITUDE*I3,* NOT FOUND IN RADIATION TABLE ISUBROUTINE GE
     1TPOT)*)
      CALL PRABT
C-----LATITUDE 38 (L(1) - L(481))
   20 L1 = 1
      GO TO 90
   30 IF(LAT - 40) 10,40,50
C-----LATITUDE 40 IL(482) - L1962))
   40 L1 = 482
      GO TO 90
   50 IF(LAT - 42) 10,60,70
C-----LATITUDE 42 (L(963) - L(1443))
   60 L1 = 963
      GO TO 90
   70 IF(LAT - 44) 10,80,10
C-----LATITUDE 44 (L(1444) - L(1924))
   80 L1 = 1444
C-----FIND THE ASPECT
   90 IF(ASPECT.NE.3HN  ) GO TO 100
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      L2 = L1 + I3
      GO TO 210
  100 IF(ASPECT.NE.3HS  ) GO TO 110
      L2 = L1 + 65
      GO TO 210
  110 IF(ASPECT.NE.3HNNE.ANO.ASPECT.NE.3HNNW) GO TO 120
      L2 = L1 + I17
      GO TO 210
  120 IF(ASPECT.NE.3HSSE.AND.ASPECT.NE.3HSSW) GO TO 130
      L2 = L1 + 169
      GO TO 210
  130 IF(ASPECT.NE.3HNE .AND.ASPECT.NE.3HNW ) GO TO I40
      L2 = L1 + 22I
      GO TO 210
  140 IF(ASPECT.NE.3HSE .AND.ASPECT.NE.3HSW ) GO TO 150
      L2 = L1 + 273
      GO TO 210
  I50 IF(ASPECT.NE.3HENE.ANO.ASPECT.NE.3HWNW) GO TO 160
      L2 = LI + 325
      GO TO 210
  160 IF(ASPECT.NE.3HESE.ANO.ASPECT.NE.3HWSW) GO TO I70
      L2 = LI + 377
      GO TO 210
  I70 IF(ASPECT.NE.3HE  .ANO.ASPECT.NE.3HW  ) GO TO 180
      L2 = LI + 429
      GO TO 210
  180 IF(ASPECT.EO.3H   ) GO TO I90
      WRITE (6,920) ASPECT
  920 FORMAT(*0ASPECT *A3,* IS INVALIO*)
      CALL PRABRT
C-----NO ASPECT IMPLIES A HORIZONTAL SURFACE
  190 IF(SLOPE.EO.0) GO TO 200
      WRITE (6,930) SLOPE
  930 FORMAT(* WITH A SLOPE DF*I3,*, AN ASPECT MUST BE SUPPLIEO, BUT NON
     1E WAS FOUNO*)
      CALL PRABRT
  200 L2 = LI
      GO TO 310
C-----FIND THE SLOPE WITHIN THE TABLE
  210 IF(SLOPE) 230,220
  220 WRITE (6,940) ASPECT
  940 FORMAT(*0WITH AN ASPECT OF *A3,*, A ZERO SLOPE IS INVALIO*)
      CALL PRABRT
  230 IF(SLOPE - I0) 240,310,250
  240 WRITE (6,950) SLOPE
  950 FORMAT(*0SLOPE*I3,* IS INVALIO*)
      CALL PRABRT
  250 IF(SLOPE - 20) 240,260,270
  260 L2 = L2 + 13
      GO TO 310
  270 IF(SLOPE - 30) 240,280,290
  280 L2 = L2 + 26
      GO TO 310
  290 IF(SLOPE - 40) 240,300,240
  300 L2 = L2 + 39
C-----STORE THE VALUES AT THE HORIZONTAL SURFACE ANO COMPUTE THE
C----- PERCENTAGE WHICH IS INCIOENT TO THE SLOPE
  310 L1 = L1 - 1
      L2 = L2 - I
      OO 320 I = 1,13
      J = I + 11
      POTENT(J) = L(L1+I)
      SLPASP(J) = FLOAT(L(L2+I))/POTENT(J)
  320 CONTINUE
      GO TO 340
C-----REAO THE CARDS RATHER THAN USING THE TABLE
  330 REAO (5,960) NAME,(POTENT(I),I=12,24),NAME1,(SLPASP(I),I=12,24)
  960 FORMAT(AI0,5XI3F5.0/AI0,5X13F5.2)
      IF(NAME.EO.IOHPOTENTIAL .AND.NAME1.EO.10HSLOPE/ASPE) GO TO 340
      WRITE (6,970) NAME,NAMEI
  970 FORMAT(*0SINCE THE LATITUOE, ASPECT ANO SLOPE WERE NOT SPECIFIEO,
     1THE -POTENTIAL RAD- ANO -SLOPE/ASPECT- CAROS WERE EXPECTEO.*/
     2 *0HOWEVER, COL I-10 OF THE TWO CAROS CONTAIN -*AI0,*- ANO -*A10,
     3 *-.*)
      CALL PRABRT
C-----FILL THE LOWER PORTION OF THE ARRAYS
  340 DO 350 I = 1,I1
      POTENT(I) = POTENT(24-I)
      SLPASP(I) = SLPASP(24-I)
  350 CONTINUE
      WRITE (I9) POTENT,SLPASP
      RETURN
      END
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Subroutine PARAMS

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      SUBROUTINE PARAMS
C-----REAO THE PARAMETER OECK
      COMMON OATIME(2),OECMAL,NRMANG,NSAVEO,NYEARS,PLNOPT(19),PLUNIT(6),
     I RECOVR,REGION(B),REGOPT(5),SAVE,SEDRN2,WEIGHT
      INTEGER OATIME,PLNOPT,PLUNIT,RECDVR,REGION,REGOPT,SAVE,SEORN2
      OIMENSION OECIDS(3),ETDALY(12),AIRTMC(4)
      INTEGER ASPECT,SLOPE,VEGTYP
C-----REAO THE SUBSTATION CONSTANTS
      READ (5,920) NAME,TCOEFF,COVOEN,CDMAX,VEGTYP,TRSHLD,TMPMLT,WILTPT,
     1 DECIOS,LAT,ASPECT,SLOPE
  920 FORMAT(A10,10X3F5.2,4XI1,2F5.0,4F5.2,IXI2,IXA3,IXI2)
      IF(NAME.EO.10HSUBSTATION) GO TO 20
      WRITE (6,921) PLUNIT
  92I FORMAT(*0THE SUBSTATION CONSTANTS CARO DOES NOT FOLLOW THE SUBSTAT
     1IDN ID CARD ENTITLED*/1X6A10)
      CALL PRABRT
C-----ENSURE THAT THE WILTING POINT IS NEGATIVE
   20 WILTPT = -ABS (WILTPT)
C-----CONVERT THE MELT THRESHOLO TO CENTIGRAOE
      TMPMLT = (TMPMLT - 32.0) * 0.55555555555555
      IF(CDMAX.GE.COVOEN.ANO.CDVOEN.GE.0.0) GO TO 30
      WRITE (6,922) PLUNIT,COVDEN,CDMAX
  922 FDRMAT(*0ON THE SUBSTATION IO CARD ENTITLED *6AI0/* THE COVER OENS
     IITY SPECIFIED IN COLUMNS 26-30 (*F5.2,*) IS EITHER NEGATIVE OR IT
     2IS GREATER THAN THE MAXIMUM COVER OENSITY*/*   IN CDLUMNS 31-35 (*
     3F5.2,*)*)
      CALL PRABRT
   30 IF(VEGTYP.EQ.I.OR.VEGTYP.EO.2) GO TO 60
      IF(VEGTYP.EO.3) GO TO 40
      IF(COVDEN.EO.0.0.AND.VEGTYP.EO.0). GO TO 60
      WRITE (6,923) VEGTYP,PLUNIT
  923 FORMAT(*0INVALIO VEG TYPE (*I1,*) IN COLUMN 40 OF SUBSTATION ID CA
     IRD ENTITLEO *6A10/* VEGETATION TYPE = 1 (LDOGEPOLE PINE), = 2 (SPR
     2UCE FIR), = 3 (DECIOUOUS)*)
      CALL PRABRT
C-----DECIOUOUS FOREST - CHECK THE WINTER VALUES FOR COVER OENSITY ANO
C----- TRANSMISSIVITY COEFFICIENT
   40 IF(DECIDS(3).GE.OECIDS(2).ANO.OECIOS(2).GT.0.0) GO TO 60
      WRITE (6,924) PLUNIT,OECIDS(2),OECIOS(3)
  924 FORMAT(*0DN THE SUBSTATION ID CARO ENTITLEO *6A10/* THE COVER DENS
     IITY SPECIFIED IN COLUMNS 61-65 (*F5.2,*) IS EITHER NEGATIVE OR IT
     2IS GREATER THAN THE MAXIMUM COVER OENSITY*/*   IN COLUMNS 66-70 (*
     1F5.2,*)*)
      CALL PRABRT
C-----REAO THE INITIAL CONOITIONS CARO
   60 READ (5,930) NAME,SIMTM1,PREWEO,RECHRG
  930 FORMAT(A10,I0X3F5.2)
      IF(NAME.EO.10HINITIAL CO) GO TO 70
      WRITE (6,93I) PLUNIT
  931 FORMAT(*0THE INITIAL CONOITIONS CARO OOES NOT FOLLOW THE SUBSTATIO
     IN CONSTANTS CARD IN THE CAROS FOLLOWING THE SUBSTATION IO CARO ENT
     2ITLED*/1X6AI0)
      CALL PRABRT
C-----REAO THE OAILY ET VALUES
   70 REAO (5,940) NAME,ETOALY
  940 FDRMAT(AI0,I0X12F5.4)
      IF(NAME.EO.10HOAILY ET  ) GO TO B0
      WRITE (6,941) PLUNIT
  941 FORMAT(*0THE OAILY ET VALUES CARO OOES NOT FOLLOW THE INITIAL COND
     IITIONS CARO IN THE CAROS FOLLOWING THE SUBSTATION IO CARO ENTITLEO
     2*/IX6A10)
      CALL PRABRT
   B0 REAO (5,950) NAME,AIRTMC,SUMMER
  950 FORMAT(A10,10X5F5.3)
      IF(NAME.EO.10HAIR TEMP C) GO TO 90
      WRITE (6,951) PLUNIT
  951 FORMAT(*0THE AIR TEMPERATURE COEFFICIENTS CARO OOES NOT FOLLOW THE
     1 OAILY ET CARO IN THE CAROS FOLLOWING THE SUBSTATION IO CARO ENTIT
     2LEO*/1X6A10)
      CALL PRABRT
   90 IF(SUMMER.LE.0.0) SUMMER = 1.0
      WRITE (I9) TCOEFF,COVDEN,COMAX,VEGTYP,TRSHLO,TMPMLT,WILTPT,OECIOS,
     1 LAT,ASPECT,SLOPE,SIMTMI,PREWEO,RECHRG,ETOALY,AIRTMC,SUMMER
C-----GET THE POTENTIAL RAOIATION ANO THE AOJUSTMENT FACTORS
      CALL GETPDT (LAT,ASPECT,SLOPE)
C-----REAO THE FDRMAT-INDICES CARO
      CALL GETFMT
      RETURN
      ENO
```

Subroutine PRABRT

```
      SUBROUTINE PRABRT
C-----PRE-ABORT THE RUN
      WRITE (6,910)
  910 FORMAT(*0JOB PRE-ABORTEO BY A PARAMETER OECK PROOFREAOING ROUTINE
     1- NO SIMULATIONS WERE PERFORMEO ON ANY OF THE PLANNING UNITS*)
      REWIND 13
      ENO FILE I3
      CALL ABORT
      ENO
```

Leaf, Charles F., and Glen E. Brink.
1975. Land use simulation model of the subalpine coniferous forest zone. USDA For. Serv. Res. Pap. RM-135, 42 p. Rocky Mt. For. and Range. Exp. Stn., Fort Collins, Colo. 80521.

A dynamic model simulates the short- and long-term hydrologic impacts of combinations of timber harvesting and weather modification to develop management strategies for planning intervals which can vary from a few years to the rotation age of subalpine forests (120 years and longer). Management strategies may subdivide a given "planning unit," defined by environmental characteristics, into as many as eight distinct "response units," which may be managed independently. Different cutting practices may be imposed on the response units, and any number of cuttings can be made by specified years. The model contains time trend functions which compute changes in evapotranspiration, soil water, forest cover density, reflectivity, interception, snow redistribution, and sediment yield as the forest stands respond to timber harvesting.

Keywords: Computer models, coniferous forest, forest management, land use planning, simulation analysis, subalpine hydrology, watershed management.

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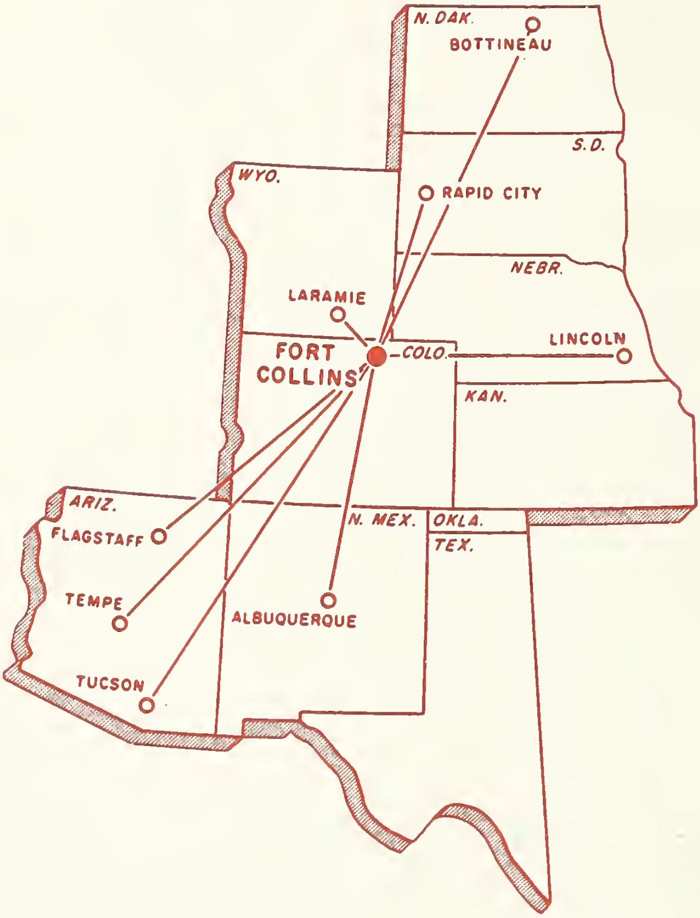
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